NUTRITIONAL STATUS OF LOW INCOME MOTHERS AND UNDER-FIVE CHILDREN IN SOUTHERN ETHIOPIA: FOCUS ON TRANSITIONAL FOOD DEVELOPMENT

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LIST OF ABBREVIATIONS

AWALE	African Women Leaders in Agriculture and Environment
ACA/NORAD	Awassa College of Agriculture / Norway International Development Research. Project
BMI	Body Mass Index
BRAC	Bangladesh Rural Advancement Committee
CSA	Central Statistical Authority (of Ethiopia)
DSM	Dried Skim Milk
EHNRI	Ethiopian Health Nutrition and Research Institute
GDP	Gross Domestic Product
IRB	Institutional Review Board (of Oklahoma State University)
MOFED	Ministry of Finance and Economic Development (of Ethiopia)
PEM	Protein Energy Malnutrition
SNNPR	Southern Nations and Nationalities People's Region (Ethiopia)
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WHO	World Health Organization

CHAPTER I

INTRODUCTION

Children's nutritional status and health reflects their socio-economic environment (Kinfu, 1999). The future development of Ethiopia relies on children by developing their full potential to become productive citizens. Adequate food containing all nutrients beginning at conception is an integral component of optimum development. However, most children in Ethiopia are currently malnourished and exposed to deficiency diseases (Ferro-Luzzi et al., 2001).

Under ideal conditions where the mother is well nourished, the first six months of a child's life are protected by breastfeeding (Michaelsen and Friis, 1998). However, as children grow, the need for energy and other nutrients cannot be met by breastfeeding alone. For example Lindstrom and Berhanu (2000), using data from Ethiopia, reported a direct relationship between extended breastfeeding beyond two years and higher child mortality. Thus, children between six months and five years of age who do not receive appropriate transitional food are at risk of being underweight, wasted, or stunted. Based on a national survey, more than one in two (52%) Ethiopian children under five years of age are stunted and more than one in four children (26%) are severely stunted (CSA, 2001). The major deficiency diseases in Ethiopia are protein energy malnutrition (PEM), vitamin A deficiency, anemia, and goiter (Abuye et al., 1999; CSA, 2001; Haidar, Demisse, Gebre-Sillasie et al., 1996; Haidar & Tibeb, 1998; Lulseged & Fitwi, 1999; Wolde-Gebriel & Demeke, 1993; Wolde-Gebriel et al., 1991). Recent findings also

suggest the role of zinc deficiency in causing stunting (Neumann et al., 2002; Umeta et al., 2000). These deficiency diseases are recognized as major causes of child morbidity and mortality and of impairment of cognitive development required for effective learning.

The causes of childhood malnutrition are complex and often interrelated, caused by various factors ranging from political unrest to specific diarrheal diseases (Smith and Haddad, 2000). However, after the first relatively healthy six months of a child's life, the initial diet-related cause of malnutrition may occur during the transitional phase when children are weaned from breast milk (Egounlety, 2002). Most often children are weaned from breast milk to gruels made from cereals or starchy root crops, or to the regular family diet. Children in low-income households of southern Ethiopia are weaned to the staple diet of corn or kocho, a starch processed from a root crop called enset (*Enset ventricosum*) (Tedla and Abebe, 1994). Enset is considered a strategic root crop due to its drought tolerance and extended storage capacity. However, its extremely low protein content of 0.6g/100g (EHNRI, 1997) makes it less appropriate for infants who need higher level of protein for growth and development in the early years of life (Latham, 1997).

Ideally, children should be weaned to foods of high biological value. However, in Ethiopia these foods are expensive and not accessible to low-income families. An alternate method of improving infant foods could be the use of legumes along with the addition of fruits or vegetables (Choi and Sohn, 2001; Kanashiro et al., 1991). Legumes are relatively low cost compared with animal foods. Although legumes are part of the diet in Ethiopia, they are not commonly used for infant feeding. Hence complementing

local food resources with legumes would benefit children by enhancing the amino acid balance of transitional foods.

In addressing the need for promotion of better transitional foods, family and community participation is necessary. Including the family and the community in developing transitional food moves beyond focusing on the mother as the only caregiver. Community participation involves men and women in the community whose lives are affected by planned development projects (Green, et al., 1997). The concept of family-centered care practiced for children with special health needs in the United States is recommended as an important approach to use in a community setting due to its positive effects on promoting children's well being (Patterson and Hovey, 2000). The family centered approach stresses that children are best cared for in a family setting regardless of economic level. This approach is relevant to developing countries where the extended family is involved in meeting children's needs.

To reduce malnutrition, which begins early in life, community-based trials have been used to distribute centrally developed and commercially marketed transitional foods (WHO, 1998). Other strategies have focused on local solutions such as promotion of vegetable gardens, involvement of mothers in transitional food formulations, and evaluation of communication strategies used in transitional food promotion (WHO, 1998). Transitional feeding projects in Peru (Kanashiro et al., 1991), Nigeria (Guptill et al., 1993), and Bangladesh (Brown, 1992) focused on ways to introduce enhanced transitional foods in community settings. An example is the Bangladesh Rural Advancement Committee (BRAC) which aimed to improve nutritional status of infants older than 5 to 6 months during the 1980s (Brown, 1992). The BRAC program

component consisted of messages with specific recipes for children, appropriate feeding behavior, and improved food hygiene given to all caregivers including mothers, fathers and grandmothers. Village workers conducted in-home demonstrations showing how to enrich transitional foods with different ingredients. Education messages were developed with community representatives. Impact evaluation indicated greater consumption of transitional food, higher estimated protein intake, and more weight gain in intervention children as compared with control children. It was concluded that culturally appropriate messages are necessary in promoting improved transitional feeding practices.

In view of the malnutrition caused by the lack of adequate diet, the need for nutrition intervention and improved transitional foods along with increasing food availability of households is apparent. This further implies the need for nutrition policy initiatives as well as integrated programs targeted to Ethiopian children in low-income households.

In this study the word " transitional foods" refer to foods that are designed to meet the physiological or nutritional needs of infants over six months as defined by WHO (1998).

Research Questions

To define this study the following research questions were formulated:

1. What are the food consumption patterns and child feeding practices of the study area?
2. What is the nutritional status of children in the study area as compared with the standards for children of similar age and gender?

3. What are the best combinations of local food resources for transitional food development?
4. What are maternal preferences for transitional foods for their children?
5. What are the views of government representatives to improve nutritional status of children in Ethiopia?

Implications

Impaired nutritional status of children is a major problem in Ethiopia. The results of this study could help alleviate child malnutrition by identifying factors associated with cultural practices affecting children. The use of local food resources in transitional food development along with collaborative work with mothers is believed to provide long lasting benefit.

Limitations

Sample size: The total sample size of 71 mother and child pairs is adequate to understand the food consumption and child feeding patterns in the Southern Nations and Nationalities People's Regions (SNNPR) because of the limited diet variety and related family feeding practices. It is possible to make recommendations for improvement to groups with similar income level and food habits in the SNNPR. However it is not appropriate to extrapolate to a wider population. The small sample size did not allow stratification of children into different age groups.

Selection bias: Subjects for this study were purposefully selected low-income mothers attending the child feeding service at Bushulo Health Center. The response they provided to the interview questions could be influenced by prior knowledge gained from

the program. Furthermore the children were likely to be more malnourished than the population in the area because only malnourished children were enrolled in the program.

Interviewer bias: Although local interviewers were trained, it is possible that they misunderstood or misinterpreted either the questions or the responses of subjects.

Format of the Dissertation

The dissertation has seven chapters. Chapter I introduces the research questions along with implications and limitations. Chapter II presents a review of the literature related to the current study. Chapter III describes the qualitative and quantitative methods employed in conducting this study. Qualitative methods used included personal interviews and discussion with selected community members. Quantitative methods used included anthropometric measures of subjects, chemical analysis of food samples and sensory evaluation of transitional foods. Chapters IV to VI include separate articles, related to the nutritional status of households in the study area. The last chapter presents conclusions and recommendations along with views of community representatives regarding children's nutritional status.

CHAPTER II

LITERATURE REVIEW

General Description of Ethiopia

Ethiopia is located in the horn of Africa between 3 and 15 degrees north latitude and 33 and 48 degrees east longitude (CSA, 2001). The total area of the country covers 1.1 million square kilometers with varying landscape features of high lands and low lands. Agriculture contributes 54% of the gross domestic product (GDP) and is a source of employment for 80% of the population (CSA, 2001). Agricultural productivity is suboptimal and use of modern technology is limited.

In the year 2000, the total population in the country was estimated at 63.5 million (CSA, 2001). Among these, 47.1% were within the age range of 0-14 years, 49.9% were between 15-64 years and 3.3% were older than 65 years. Approximately 86.4% lived in rural and 13.6% in urban areas. The annual population growth rate in the year 2000 was 2.6% and contraceptive use was 8%. The average energy intake in 1995 was only 73% of WHO's recommendation (UNDP, 2002). National data on education indicates that only 38% of Ethiopian males and 23% of females completed some formal education.

The SNNPR where this study was conducted borders Kenya in the south and has a population of 11 million of which 93.2% live in the rural areas. There are more than 45 ethnic groups in the state and the working language is Amharic. A high level of fertility (6.8 children per woman of reproductive age) and a low level of contraceptive use (4%)

were reported in the region (BOPED, 1996). Based on the 1998 health and nutrition survey, 95% of women in the SNNPR gave birth at homes, 2.4% at health centers, 1.3% at hospitals, 0.4% at clinics, 0.2% stated as other, and 0.7% not stated (CSA, 1999).

The nutritional status of mothers and children in the SNNPR is similar to other regions in Ethiopia as a whole, though the region has largely escaped the severe famine conditions that have affected other regions in the past. On the other hand, only the Amhara region has a more severe incidence of stunting (CSA, 2001). For SNNPR, stunting in children under five years old is 55.4% with 33.2% severely stunted (less than 3SD, with mean *Z-score* for stunting of –2.3) (CSA, 2001). Together with protein energy malnutrition, micronutrient deficiencies recognized globally by the WHO (2002) also exist in SNNPR, although the prevalence of night blindness during pregnancy was lower than other regions (CSA, 1999). The diet of low-income rural people in SNNPR is dominated by corn or a root crop (Enset), and intakes of animal source foods are minimal, thus efforts to improve the nutritional status of children needs a high priority (Branca et al., 1993).

Role of Nutrition on Growth and Development of Children

Impact of Nutrition on Growth

The strongest impact of nutrition in regulating growth occurs during infancy (Michaelsen and Friis, 1998). This suggests the need for adequate nutrition during prenatal and infancy periods. Poor nutritional status delays the onset of childhood growth, which may not be regained later if the child remains in the same nutritional environment. Children with a history of malnutrition show delayed onset of menarche,

reduction of pubertal growth spurts, and lower levels of insulin-like growth factor compared with healthy control children (Galler, et al. 1987B). Such children with a histry of malnutrition were reported to be stunted and to have little chance to attain their full growth potential if left in the same environment.

The World Health Organization (WHO) recommends timely introduction of safe and adequate transitional food after six months to supplement breast-milk (WHO, 2001). In reference to transitional foods, diet adequacy relates to the total food energy while diet quality relates to availability of protein including essential amino acids and micronutrients to support growth of children (Neumann & Harris, 1999). Major components of transitional foods that affect growth include energy, protein, and micronutrients (Michaelsen & Friis, 1998). Specially, vitamin A is needed for healthy vision, and gene expression of growth hormones (Stipanuk, 2000), and zinc is needed for enzymatic activity and promotion of healthy appetite (Gershwin et al. 2000). Iron is needed for tissue growth and expansion of blood volume (Neumann & Harris 1999). Table 2.1 presents recommended amounts of energy and selected nutrients that are of concern in the diet of young children

Table 2.1Energy and selected nutrient requirements in the first two years of life

Age (months)	Energy recommendations		Protein	Selected nutrients			
				Vitamin A	Iodine	Iron[2]	Zinc
	Kcal/kg/d	Kcal/d	(g/d)	(µg RE/d)	(µg /d	mg/d	mg/d
0-2	116	520	9.6	350	50	-	-
3-5	99	662	8.5	350	60	21	2.8
6-8	95	784	9.1	350	60	21	2.8
9-11	101	949	9.6	350	60	21	2.8
12-23	106	1170	10.9	400	70	12	2.8

[1]World Health Organization (WHO). (1998). *Complementary Feeding of Young Children in Developing Countries: A Review of Current Scientific Knowledge*. Geneva: WHO pp 49 and 93.

[2]Values for iron represent for low bioavailability

Impact of Nutrition on Cognitive Development

Current knowledge reveals that growth retardation, impaired resistance to infection and limited work capacity are not the only effects of childhood malnutrition. In addition, the impact of malnutrition on cognitive development, school performance, and reduced physical activity has become a serious concern (Grantham-McGregor et al., 1998). A follow up study in Barbados showed that girls and boys (11-18 years) with a past history of malnutrition had lower IQ and conservation scores compared with a healthy control group matched for sex and age (Galler et al., 1987A). These effects of early malnutrition were considered significant even when environmental factors were controlled (Galler et al., 1987A). Two related studies in Jamaica evaluated whether giving daily breakfast to children improved scholastic achievement through increased school attendance, increased attention to tasks and improving nutritional status (Grantham-McGregor et al., 1998; Powell et al., 1983). They reported that malnourished children showed improved fluency scores after they received breakfast compared with well-nourished children and to malnourished controls who showed no changes in scores. Furthermore, significantly higher z scores with growth measurements were reported in malnourished children with intervention indicating improved nutritional status. Noting children in this study were mildly malnourished, the researchers suggested that the benefits of school breakfast in populations from developing countries would show greater improvements in children's school performance than in developed countries.

In Kenya, toddlers who had animal source food between 18-30 months had higher levels of verbalization, with more symbolic play, which was taken to predict improved future cognitive performance (Neumann & Harris 1999). The same study indicated that

among school age children, higher anthropometric measures were related to higher cognitive test scores. These results suggest the importance of early adequate nutrition for children in order to gain maximum benefit from learning experiences.

Determinants of Childhood Malnutrition

Nutritional status is influenced by various factors such as inadequate food, poor sanitation, high prevalence of disease, and poorly developed social services. Recently, Smith and Haddad (2000) outlined six determinants of childhood malnutrition. Those with direct impact on children's nutritional status were: women's education, national food availability, women's status relative to men, and quality of the health environment. The other two named as basic determinants were national income and democracy. The following section summarizes these determinants of childhood malnutrition as they relate to the Ethiopian situation.

Impact of Women's Education and Status on Children

In developing countries increased education among women is associated with improved children's nutritional status. Smith and Haddad (2000), using data from 63 developing countries in the 25-year period from 1970-1995, reported that 43% of the total reduction of child underweight in developing countries was attributed to increases in female secondary school enrollment.

In Ethiopia, the Demographic and Health Survey (CSA, 2001) showed that children born to educated mothers had a relatively lower stunting rate (33%) as compared with children of mothers with no education (53%). Similarly, Genebo et al. (1999), using a bivariate analysis based on height-for-age data, showed a higher prevalence of stunting

in Ethiopian children of illiterate mothers (52.2%) than children of literate mothers (22.2%). Utilization of health facilities for childbirth also varied by educational level in that only 2% of uneducated women gave birth in health facilities as opposed to 41% of mothers with secondary or higher education. A report from UNICEF (1993) also indicated that Ethiopian literate mothers were more aware of the need for immunization and family planning services than non-literate mothers.

The Institute of Medicine (IOM, 1990), indicated the status of women is among major factors that determine low gestational weight gain during pregnancy, an indicator of favorable pregnancy outcomes. In the U.S. specific maternal characteristics associated with increased risk of low gestational weight gain (<7 kg) include low family income, black race, young age, unmarried status and low education level (IOM, 1990). Low gestational weight gain is further associated with low birth weight (<2.5 kg), which is related to infant morbidity and mortality. Smith and Haddad (2000) also reported that when a woman's status relative to men increases, child malnutrition is expected to decline. A UNICEF report (1998) stressed the need to upgrade women's status through education and involvement in paid work for increased income. It further stated that investment in education and health services for women are important policy tools for improving nutrition status of children.

Food Security

Food security is a major determinant of a child's nutritional status. In areas where the food supply is low such as in sub-Saharan Africa and South Asia, national food availability is as important as women's education in determining a child's nutritional

status (Smith & Haddad, 2000). Effects of food insecurity in Ethiopia and impacts on the health of individuals are being documented. The Ministry of Finance and Economic Development (MOFED, 2002) stated that in the year 2000, about 45% of the Ethiopian rural population and 37% of the urban population faced food shortage, which suggests the potential for a negative effect on growth and development of children.

To show the effect of seasonal food fluctuation on the nutritional status of households, Pastore and colleagues (1993) conducted a study involving 203 households in southern Ethiopia. They used a food availability questionnaire and anthropometric measures for adults and children that were conducted every two months for a year. Results of post-harvest and pre-harvest anthropometric results showed that adults and children faced periods of stress reflected by negative energy balance in adults (low BMIs) and wasting and growth retardation in children. A greater loss in weight-for-height was reported in children of poor households than children in rich households, which was explained by survival strategies of the rich (such as investing in non seasonal crops, and relying on off-farm income) that were not used by the poor households. Another study on fluctuation of household food supplies in Ethiopia indicated that children's nutritional status was better soon after harvest when there was more food in the house and worse when the food stores in the house were finished (Branca et al., 1993).

About 50-70% of respiratory infections, malaria, measles, and diarrheal diseases in childhood are attributed to undernutrition (WHO, 2002) that could be related to food deficit as a result of seasonal food fluctuation. For instance, in times of food shortage, milk and milk products are not usually available for the household because livestock are sold as a survival strategy (Young & Jaspars, 1995). Animal source foods are both energy

and nutrient dense and facilitate a healthy immune system and stimulate growth. In Uganda, Tumwine and Barugahare (2002) used a cross sectional nutritional survey to identify risk factors for child malnutrition. They reported that not consuming milk was the major risk factor for stunting.

Kinfu (1999) indicated the risk of malnutrition in Ethiopia was 35% higher for children born to landless families compared with those born to households with land holdings even as low as 0.3 hectares. The lack of available food in different sectors of the population suggests the need for targeted nutritional intervention projects to allow young children of poor households to survive critical periods.

The Health Environment

The quality of the health environment including clean drinking water, sanitation, and health services was the third determinant affecting children's nutritional status (Smith and Haddad, 2000). Quality of the health environment also included improved immunization, use of oral rehydration therapy, iron fortification, and dietary improvements (UNICEF, 1998).

A major reduction (19.5%) of child malnutrition in developing countries during 1970-1995 was reported due to improvements in safe water access. However, only 24% of the Ethiopian population had access to safe water. Most (81%) urban dwellers had safe water access as opposed to only 12% of the rural population (UNICEF, 2002). Furthermore, in 2002 the immunization rate of one year old children was: 40.7% for Bacillus of Calmette and Guerin (BCG), 18.1% for Diphtheria, Pertussis and Tetanus (DPT), 30.4% for Polio, and 20.6% for measles (CSA, 2001). The poor health

environment superimposed on inadequate food intakes makes young children very vulnerable to infectious diseases.

National Income and Democracy

Income growth is considered to be an indirect determinant of a child's nutritional status (Smith and Haddad, 2000). Similarly, democracy affects a child's nutritional status by allowing investments benefiting the health of the child. Income growth per person has been identified as a vital means to reduce child malnutrition. Smith and Haddad (2000) reported that during 1970-95, about half of the reduction in child malnutrition was due to income growth. However, unless investment is made in areas such as increasing women's education and food supply, income growth by itself does not reduce child malnutrition. On the other hand democracy was considered less a factor in reducing child malnutrition in developing countries than national income growth.

Anthropometry and Assessment of Nutritional Status

The nutritional status of children is often assessed using anthropometry because these methods are inexpensive, non-invasive and universally applicable (de Onis et al., 1996). The assessment of nutritional status using anthropometric measures depends on the concept that in a well-nourished population the distribution of children's height and weight in a defined age will approximately follow a normal distribution (CSA, 1999). Based on the understanding that all people have similar genetic potential for growth (Habicht et al. 1974), the World Health Organization in 1978 recommended use of the International Reference Population defined by the U.S. National Center for Health Statistics (NCHS/WHO) for comparative assessment of nutritional status (WHO, 1983).

In using anthropometric indices, children who are less than two standard deviations (SD) (*Z-scores*) from the reference median are considered to be malnourished, and those below three standard deviations from the reference population are severely malnourished (Pelletier et al., 1994). Multiple indices of growth are necessary for a realistic assessment of nutritional status (Zetlin et al., 1992); and the use of the right tools, along with standard measurement procedures and correct interpretations are vital in using anthropometry (Unted Nations, 1986).

Common Anthropometric Measures

The basic anthropometric measures most widely used include weight (mass), height, body circumference (waist, hip, head and upper arm), as well as skinfold measurements (Vorster et al., 1997). The combined use of basic anthropometric measurements such as weight, height, body circumference measures, and skinfold measurements give indices that may be used for interpretation of body measurements (Zemel et al., 1997). Recommended indices used to assess nutritional status include weight-for-height, height-for-age, weight-for-age, or body mass index (kg/ht (m^2)). Each of these indices gives different information about the nutritional status of children.

Weight-for-height (Wasting)

Weight-for-height is considered as a sensitive index of current nutritional status. It is also considered independent of age between the ages of one and ten years old, it is thus considered important where children's age is not known accurately (Gibson, 1990). The relationship between weight and stature enables professionals involved in assessing the

nutritional status of children to determine if wasting has occurred. Low weight-for-height indicates wasting as a result of loss of body fat and muscle, a nutritional deficiency of recent incidence caused by recent illness especially diarrhea in children, improper feeding, acute food shortage, or in most cases, a combination of several factors (Gibson, 1990). Since weight-for-age measure is sensitive to changes in nutritional status is important in evaluating the impact of nutrition intervention more than height-for-age measures.

Height-for-age (Stunting)

The height-for-age index is a measure of linear growth retardation that reflects cumulative growth deficits (Gibson, 1990). Growth retardation (stunting) is caused by several factors including chronic and inadequate dietary intake, frequent infection or poor socioeconomic environment. Height-for-age in a population reflects the presence of malnutrition over a long period of time and does not vary much with data collection season (CSA, 2001). Based on height-for-age measures, a 25-50% stunting rate in children is regarded as an indicator of moderate malnutrition in a population, and more than 50% indicates severe malnutrition (WHO, 1986). Stunting in a community has the potential to reduce adult size and work capacity (Rush, 2000). Furthermore small maternal stature is identified as a risk factor for pregnancy complications and for having low birth weight leading which could lead to childhood stunting and a continued risk for intergenerational link of malnutrition (Rush, 1990). Reflecting the link between maternal malnutrition and children's status, UNICEF (1998) summarized risk areas as obstructed

labor in women who were stunted in childhood; high maternal mortality for anemic women; miscarriage and stillbirth with iodine deficiency; neural tube defects, maternal mortality and morbidity as well as increased risk of low birth weight with folate deficiency in the first month of pregnancy.

Weight-for-age (Underweight)

Weight-for-age in young children aged six months to seven years of age is taken as an index of acute malnutrition and is used more to assess protein-energy malnutrition or overnutrion, mainly in infancy when taking length measurement is difficult (Gibson, 1990). Using weight-for-age as the only measurement could lead to misinterpretation of children's nutritional status. Low-weight-for age may not necessarily indicate wasting, but the child could be short because of short parents. Thus the possibility of overestimating malnutrition is considered high if only weight-for-age is used to assess children's nutritional status (Gibson, 1990). Overall, when 20-40% of a population is underweight the population is considered moderately malnourished and if more than 40% of the population is underweight, a severe problem exists in the community (WHO, 1986).

Mid-arm Circumference

Mid-arm circumference is a composite measure of muscle and fat stores at a site that is most sensitive to current nutritional status (Frisancho, 1981). This measure is considered to be independent of age for children between the ages of one and five years

and can be used to assess malnutrition using cutoff points (Gibson, 1990). Mid-arm-circumference measures have been used to screen protein-energy malnutrition when the age of the child is not known (Gibson, 1990). Standard procedures for measuring mid-arm circumference are documented in the literature (Mascarenhas et al., 1998). In taking Mid-arm circumference measures nonstretchable tapes are used and triplicate measures are taken to the nearest 0.1 cm. The measure is taken at the mid point between the olecranon and acromion of the upper left arm. It is recommended to place the tape around the arm without compressing the soft tissue (Mascarenhas et al., 1998).

Body Mass Index (BMI)

BMI is an index of a person's weight in relation to height. BMI is determined by dividing the weight in kilograms by height in meters squared (Lee and Nieman, 1996). The assessment of nutritional status in children using BMI-for-age charts starts at 24 months. BMI for children is age and gender specific and is used as a screening tool to identify individuals who are underweight or overweight. Since BMI for age is consistent with adult index, it is considered as an important tool to track body size starting two years to adult hood. BMI-for-age is used to screen overweight or at risk to overweight which is correlated risk of cardiovascular disease, hyperlipidemia, elevated insulin and high blood pressure (CDC, 2000). BMI measures are also used as indicator of nutritional status. In women of reproductive ages a BMI less than 19.8 indicates underweight and a normal weight is represented by a BMI of 19.8-26. On the other hand a BMI $\geq$ 26 to 29 is considered overweight and $\geq$ 29 indicates obesity (IOM, 1990). Both underweight and

overweight are considered risk factors for affecting the health condition of an individual.

Table 2.2 Summary of anthropometric indicators of a child's nutritional status

Nutritional Indicator	Causes	Prevalence
Chronic malnutrition or low height-for-age	Also known as *stunting*, this condition usually reflects one or a combination of the following factors over a long period or time: poor care, poor feeding practices, exposure to illness.	A prevalence of stunting between 25-50% is moderate; a prevalence of stunting over 50% is severe.
Acute malnutrition or low weight-for-height	Also known as *wasting*, this condition is typically the result of severe food shortages or famine or acute illness.	Prevalence of wasting over 5% signifies a problem deserving immediate attention and the possibility of famine.
Underweight malnutrition or low weight-for-age	Also known, as *under nutrition or low weight*, this measurement doesn't distinguish between children who are stunted and those who are wasted.	Low weight-for-age has some predictive value for mortality, and is thus a good indicator of long-term surveillance Populations with 20-40% of children underweight are moderately affected; those above 40% are severely affected.

Source: Food Aid Management (2003)

Maternal and Childhood Nutrition in Ethiopia

Poor prenatal nutrition is associated with poor pregnancy outcomes such as low birth weight, which contributes to high infant mortality (IOM, 1990). A national survey indicated that more than three in ten women (33.3%) had a BMI $\leq$18.5 indicating a serious energy deficiency among women (CSA, 2001). According to UNICEF (2002), 12% of infants in Ethiopia had low birth weight (defined as less than 2.5 kg) indicating poor maternal nutrition during pregnancy.

Ethiopian women and children in low-income households are the most malnourished members of the population. More than half (52%) of Ethiopian children under five years of age were stunted, and more than one in four (26%) were severely stunted (CSA, 2001). The degree of stunting increased with age; only 11% of children less than six months were stunted, but 60% of children three years and older were stunted. This indicates that malnutrition is a major problem in different groups of the population.

Malnutrition is one factor that shortens life expectancy. Life expectancy in Ethiopia is 51 for males and 54 years for females (CSA, 2001). The high infant and under five year mortality rates (117 and 174 per 1000 live births respectively) contribute to the short life expectancy (UNDP, 2002; UNICEF, 2002). The most critical causes of child malnutrition in Ethiopia are inadequate food intake and high prevalence of infection (CSA, 2001). The major deficiency diseases in Ethiopia are protein energy malnutrition (PEM), vitamin A deficiency, anemia and goiter (Abuye et al., 1999; CSA, 2001; Haidar, et al., 1996; Haidar and Tibeb, 1998; Lulseged & Fitwi, 1999; Wolde-Gebriel and Demeke, 1993; Wolde-Gebriel et al., 1991). These deficiencies impair the immune

system of children, which predisposes them to increased incidence of infection (Gershwin et al., 2000).

Harmful Food Habits Related to Child Health

Ethiopia is a culturally diverse country with different traditional practices. Unlike the cherished cultural values such as the care and support a woman receives from her family and neighbors after delivery, there are traditional practices with adverse effects on maternal and child health. Examples where nutrition and health education could impact behavior changes include the following.

Diet During Pregnancy

In some parts of Ethiopia, certain foods are prohibited during pregnancy by cultural practice. Recent national data indicated that 9% of women avoid certain foods during pregnancy (CSA, 2001). Foods avoided included cheese and butter (36%), vegetables such as kale (29%), milk (27%), meat (15%), and fruits (12%). Foods such as milk, cheese, banana and kale are believed by a few women to cause discoloration of the newborn's skin. High fat foods during pregnancy are discouraged to reduce extra weight gain, which is believed to cause delivery complications (Demissie et al., 1998). With the existing low BMI of Ethiopian women and delivery of low birth weight babies, the avoidance of certain foods makes women's nutritional status worse. On the other hand Rush (2000) suggested that where obstetric care is lacking, mothers' fear of delivery complications due to weight gain should be respected. In Ethiopia more than three-quarters (78%) of mothers in rural areas and 32% in urban areas received no antenatal

care (CSA, 2001). Along with this, 25% of all deaths in women aged 15-49 years were attributed to pregnancy or related causes.

Baby's First Food/Drink

Almost all (98%) of Ethiopian mothers breastfeed their babies up to 11 months, and a high proportion (88%) breastfeed for about 2 years (CSA, 1999). Regional variation in initial food/liquid given to children was reported. Only 10% of mothers gave breast milk as the child's first food in the Somalia region, but 72% in the SNNPR. The 1998 Ethiopian Health and Nutrition Survey indicated that immediately after delivery 30% of babies received fresh butter and 15% received warm water (CSA, 2001). Prelacteal fluids for babies are harmful because they introduce infection and replace the important breast milk (Prasad & Costello, 1995). Because child feeding practices are not uniform throughout Ethiopia, location specific nutrition education will be needed to fit the cultural practices of different regions in the country.

Weaning Practices and Associated Risks

The World Health Organization recommends exclusive breastfeeding up to the age of six months (WHO, 1998). However, as infants increase in size and require extra energy, breast milk becomes insufficient to meet physiological needs. During this time the introduction of adequate and hygienic transitional food is recommended to supplement breast milk (WHO, 1998).

The weaning process in developing countries may be gradual or abrupt. In gradual weaning, children are slowly introduced to the family's diet while in abrupt weaning the introduction to family diet is sudden often caused by a mother terminating breastfeeding when she realizes that she has conceived. In some cultures breastfeeding during pregnancy is considered harmful for the baby (CSA, 2001).

In most developing countries such as Ethiopia, common infant weaning foods are cereal or root crop-based. Studies conducted on weaning food in Ethiopia indicated that weaning foods are made from the adult's diet, which include teff (a small cereal grain) or corn made into gruel or porridge (Bekele and Berehane 1998; Wolde-Gebriel, 2000). In West African countries such as Nigeria, Ghana, and Sierra Leone, infant foods include fermented corn, millet, sorghum, starchy roots and tubers (Michaelsen & Friis, 1998). These foods are staples of the family's diet, and modifications are rarely made to increase the nutrient density to meet nutritional needs of infants.

The weaning period is considered the most critical period in an infant's life and a period of major public health concern (Latham, 1997). As infants transit from nutritious and uncontaminated breast milk to the regular family diet, they become vulnerable to serious life risks as presented below.

Risk of Diarrheal Disease: The relation between breastfeeding duration and timing of weaning food introduction, and occurrence of diarrheal diseases is documented well (Wolde-Gebriel, 2000). Early introduction of weaning foods and microbial contamination increase the risk of diarrheal diseases. Globally, among the 50-70% of

diseases associated with malnutrition (measles, malaria and lower respiratory infection), diarrheal disease is the most common childhood disease (WHO, 2002). In Ethiopia 24% of all children less than five years of age had diarrhea at sometime during the two weeks prior to the National Demographic and Health Survey (CSA, 2001). Children 6-23 months old were reported to be more prone to diarrheal disease than other age groups. Children in rural areas were at higher risk (25%) than children in urban areas (17%).

Poor Nutrient Density and Bulkiness: Traditional weaning foods in Ethiopia may have poor nutrient density and bioavailability due to high concentration of fiber and inhibitors (Urga & Narasimha, 1998). Bulkiness of traditional weaning foods is a major problem in children's diets. In explaining the problem of bulkiness in starch-based weaning foods, Michaelsen and Friis, (1998) stated that for adults and older children it may be possible to obtain adequate protein from starch based foods by having large servings. However, for infants with limited gastric capacity ad higher protein needs, it is impossible to have large enough servings to provide adequate protein. For example, a six-month-old infant must consume about 920 g of corn gruel to meet a daily energy need of 740 kcal and 13 g protein.

Crop based weaning foods are low in protein, vitamin A, zinc and iron (Gibson and Ferguson, 1998). These nutrients are of special importance because of their impact on physical and cognitive development of children (Neumann and Harris 1999). Increasing the energy density of cereal or root crop-based transitional foods becomes a major challenge due to the gelatinization of the starch during boiling, which requires adding a large amount of water to obtain the proper consistency (Egounlety, 2002).

Alternative ways to increase energy density without increasing viscosity have been suggested through addition of oil, adding a non-gelatinous carbohydrate such as sugar or using food processing techniques such as germination and fermentation (Mugula and Lyimo, 1999; Treche and Mbome, 1999). However adding too much oil or sugar is not highly recommended because it focuses on energy increase alone without considering protein and micronutrient density of the final mixed transitional food (WHO, 1998). Enhancing the nutrient density of transitional foods using local food resources is necessary mainly in low-income households where the variety of food resources is limited. Hence the use of more nutrient-dense foods, especially legumes, is recommended to enhance nutritional value of starch-based weaning foods.

Transitional Foods

The Concept of Transitional Foods and Aspects of Child Feeding

The term "transitional foods" is a relatively recent concept used in relation to child feeding practices. To avoid inconsistent use of terms WHO (1998) created a working definition for terms used in describing child feeding situations and grouping of children in age related categories.

- *Exclusive breastfeeding*: refers on entire dependence on breast milk for all fluids, energy and nutrients, except for medicinal supplements.
- *Almost exclusive breastfeeding*: the use of only water or other non-nutritive liquids in addition to otherwise exclusive breastfeeding.

- *Partial breast feeding*: mixed feeding with breast milk and other sources of energy and nutrients

The term most commonly used to describe child feeding in addition to breastfeeding was *complementary feeding*. Early definitions of complementary foods included to any nutrient-containing food or liquid given to children besides breast milk. However, the current definition of complementary foods does not include sugar water or any inferior formulas that are not appropriate for children. Rather complementary feeding as described by WHO (1998) includes two aspects:

- *Transitional foods*: complementary foods specially designed to meet the physiological or nutritional needs of children (Fig. 2.1). Until the child is able to consume family foods, transitional foods are recommended to continue with breast feeding.
- *Family foods*: complementary foods not different from family foods.

Because *weaning* implies complete termination of breast milk, the term is not used in current literature to describe complementary foods. The term weaning foods implies that the food is meant to totally replace breast milk (WHO, 1998).

In this study the term transitional food is used to indicate the nutritional enhancement of the traditional crop-based transitional foods to meet children's needs.

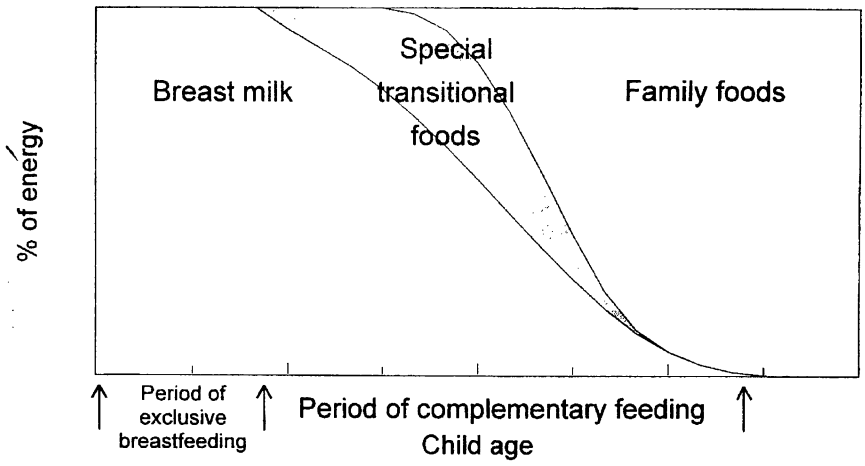

Figure 2.1 Children's energy intake in relation to age (Source: WHO, 1998)

Age for Introducing Transitional Foods

In general there is a controversy about the best time to introduce transitional foods to infants. Based on available literature, the commonly reported time lies between four and six months (WHO, 1998). Starting transitional foods as early as four months could reduce the growth-faltering problem, which starts at about four months, but is also a controversy disadvantage as it could lead to diarrheal risk (WHO, 1998).

WHO (1998) noted that data are lacking from controlled intervention studies to determine the appropriate age for transitional feeding. However, there is a consensus that infants should be exclusively breastfed until six months.

Simondon and colleagues (1996), using a randomized controlled trial in four different countries (Congo, Senegal, Bolivia, and New Caledonia), reported introduction of high quality transitional food with complete breastfeeding at 4-7 months. A maximum of 200 kcal was fed to the 4-month infants and a double portion to older ones. Except for the gains in length in Senegal (0.58 cm in the 4-5 month period) and in Bolivia (0.41 cm

during the 5-6 month period) no positive effect during any other period was reported in the four countries. Furthermore, no significant impact of supplementation on weight gain was reported except for the small negative effect (-0.17 kg) after 5 to 6 months of feeding in Congo. The investigators suggested the transitional food could have displaced breast milk, or prenatal rather than postnatal factors may have affected infant growth during the study period. The result relates to the recommendations by WHO (1994) that children should be exclusively breastfed up to six months and transitional feeding should begin after six months.

Regarding the appropriate age to introduce transitional food and breastfeeding, the World Health Organization has forwarded several recommendations since the 1990s, including the following:

- The 1990 World Health Assembly (Resolution 43.3) stressed exclusive breastfeeding in the first 4–6 months (Akre, 1989).
- In 1992 the 45th World Health Assembly (Resolution 45.34) reaffirmed exclusion of foods or drinks besides breast milk until 6 months with later introduction of locally available and safely prepared energy-rich foods in addition to breast milk (WHO, 1992).
- In 1994 the 47th World Health Assembly (Resolution 47.5) urged the fostering of proper transitional feeding practices starting at the age of 6 months with continued breastfeeding (WHO, 1994).
- In 1995 the World Health Organization Health Committee reaffirmed the need for exclusive breastfeeding and the introduction of transitional foods to begin at 4-6 months (WHO, 1995).

Based on the above points and the high incidence of microbial contamination of transitional foods, the World Health Organization recommended delayed introduction of transitional foods until close to the 6th month (WHO, 1998). Contrary to the WHO recommendation, the introduction of prelacteal feeding takes place prior to 6 months in

Ethiopia. The Ethiopian Demographic and Health Survey (CSA, 2001) indicates 40% of children 4-5 months were exclusively breastfed, 18% had plain water in addition to breast milk, 11% had other water-based liquids, 21% consumed other milk, and 10% consumed transitional foods. On the other hand, only 44% of infants received semi-solid foods at 6-9 months indicating the risk of nutritional deficiency due to increased body demand.

Improving Traditional Crop-Based Transitional Foods

Introduction of hygienic transitional food at about six months of age is recommended to supplement breastfeeding (WHO, 1998). WHO defines transitional food as a safe and hygienically prepared nutrient-containing food or liquid given to children after six months of life to meet particular nutritional and physiological needs of the young child by supplementing breastmilk.

Ideally, transitional foods made of cereals and legumes should contain animal food sources such as egg, milk, chicken, and fish with high biological value to enhance the nutrient density and foster growth and development (Neumann and Harris, 1999). However, these foods are not easily available to most low-income households in developing countries.

In reviewing the role of animal source foods in the diets of children, Neumann and Harris (1999) reported findings from the Human Nutrition Collaborative Research Support Program, conducted in Kenya, Mexico, and Egypt from 1983 to 1987. Food intake and related factors were observed for one to two years in 250 households in each of the three sites. Results from dietary intakes in all three places reported low consumption of animal source foods, with the lowest (only 8-12% of kcal) consumption in Kenya. These plant-based diets were reported to be low in fat, zinc, iron, calcium, and

vitamins B_{12} and A. Other nutritional concerns were the high phytate and fiber that reduce zinc and iron availability, and the low milk intake of the Kenyan children. On the other hand, the diets of Egyptian children were reported to include a good intake of animal source foods (40%) such as cheese, milk, and eggs. Low-income households depended more on staple crops such as maize while the rich consumed more animal products.

To overcome malnutrition associated with poor transitional foods, legumes have been used in various studies. Combining cereals with legumes is nutritionally beneficial to complement the deficient lysine in cereals with the high lysine content in legumes and improve the protein quality (Hofvander and Underwood, 1987). Other foods recommended to increase the nutrient density include soya bean, groundnut, sesame, cottonseed, and safflower seeds.

The anti-nutrient factors inherent in legumes may be reduced by roasting, fermenting or germinating techniques which also reduce the bulkiness of crop-based transitional foods (Marero et al., 1998; Mugula and Lyimo, 1999). Roasting refers to dry heating of cereals and is reported to produce a pleasant aroma and increased acceptability of formulated products (Marero et al., 1998). Germinating cereals are also reported to improve the nutritional quality of transitional foods by increasing vitamin C and reducing phytic acid. Jirpa and colleagues (2001) reported that a cowpea flour-based weaning food that was germinated for 24-hours had a higher amino acid score (55%) than the ungerminated control (47%). Though germination has beneficial effect, an increased incidence of contamination with pathogenic bacteria and molds is reported with soaking and germination (Michaelsen and Friis, 1998). Fermentation also enhances the

bioavailability of micronutrients such as zinc though hydrolysis induced by microbial phytases present on the surface of crops or from microbial starter cultures (Gibson and Ferguson, 1998)

Mbithi and colleagues (2002) formulated a transitional food using finger millet, kidney beans, peanuts, and mangoes. They processed finger millet and kidney beans with germination, autoclaving, and lactic acid fermentation. The formulated mixture contained finger millet (62.1%), kidney beans (19.1%), peanuts (8%), and mangoes (7.7%). They reported that the mixture had 11.8% protein with a 90.2% in vitro protein digestibility, and an amino acid score of 0.84. Compared with the raw unprocessed ingredients, the mixture was higher in energy density (1.3 kcal/g), lower in anti-nutrient content such as phytates, improved availability of calcium, iron, and zinc. The vitamin A content, based on calculated values of vitamin A in ingredients used, was reported to be about 100 μg RE which is considered adequate for breastfed children 6-8 months old.

Mbithi-Mwikya and colleagues (2000) reported relative changes in the amino acid chemical score profiles of finger millet and kidney beans processed for transitional foods by sprouting, autoclaving and lactic acid fermentation. They reported increase in the total amino acids (essential and non essential), 44.2-44.9% in finger millet and 44.2-45.1% in kidney beans after processing using the three methods, which were higher than the 33.9% FAO/WHO preschool reference protein for 2-5 year olds (FAO/WHO 1991). In reporting the relative changes with each individual amino acids, they reported that while the total essential amino acids increased with all of the processing techniques used, sprouting in kidney beans led to a significant decrease in lysine, autoclaving caused a significant decrease in histidine, while fermentation significantly decreased phenylalanine and

increased tryptophan in finger millet. Overall, they concluded that sprouting, autoclaving, and fermentation significantly changed the content of a few amino acids to improve the amino acid profile, which could be suitable for producing a tropical weaning foods made of finger millet and kidney bean mixture.

In Tanzania, Mugula and Lyimo (1999) developed a finger millet-based tempe transitional food by adding either common beans, groundnuts, cowpeas, mungbeans, chickpeas, sesame and/or their mixture fermented by the *Rhizopus oligosporus* culture. They reported six different combinations: finger millet-commonbean, finger millet-commonbean-groundnut, finger millet-cowpea, finger millet-cowpea-groundnut, finger millet-mungbean-groundnut, and finger millet-mungbean-sesame with varying proportions (70:30 or 70:15:15). These mixtures were formulated into tempe following outlined procedures. Based on proximate analysis it was reported that the protein content of the fermented tempe was higher than non-fermented weaning foods mixtures. The highest crude protein (15.7%) was reported with fermented finger millet-common bean-groundnuts combination tempe compared with the non-fermented mixture (14.5%). The lysine amino acid scores for fermented finger millet tempe (61-76%) were reported to be adequate in accordance with the WHO (1985) preschool reference. They further reported all of the fermented tempe had a high amount of energy, with the highest (434.3 kcal/100 g) for the finger millet-cowpea tempe which was considered adequate for transitional food. Sensory evaluation results conducted with 25 Sokoine University of Agriculture staff and students on salted and unsalted fried fermented tempe were reported. Salted tempe had a higher overall general acceptability for taste and smell as compared with non-salted tempe for the different combinations. Furthermore, preliminary trials

conducted in a maternal-child health center and three villages involving 100 mothers and children indicated that the deep-fried snacks were accepted more than porridge (Mugula and Lyimo, 1999).

In Nigeria, Ojofeitimi and colleagues (2001) fortified cornpap (ogi), which is the traditional infant food with milk from cowpea, groundnut and soyabean. They conducted chemical analysis of the food crops, organoleptic tests, and anthropometric evaluation of children fed with these foods. Based on chemical analysis and supplementation of the cornap, they reported increased protein content of the traditional cornpap from 0.3% to 2.79% with cowpea, 3% with groundnut and 3.64% with soyabean. They also reported a significant increase in weight gain among children who were fed with the three sources of milk with cornpap and children with nutrition education (for parents) but no food, and the control group of the same age children. Based on organoleptic evaluation, the groundnut milk was identified as liked the most, easiest to prepare, and with the least cost for mothers.

Another study in Nigeria evaluated the biological quality (true digestibility, biological value and net protein utilization) of cassava based transitional foods and the effect of the feed on the weight of rat organs (Babajide et al., 2001). Transitional foods evaluated were tapioca (TAP) supplemented with roasted-sprouted soybean (SS), with and without additional (10%) malted sorghum flour (MS) and Cerelac (commercial weaning food) used as the control diet. They fed each weaning food and water to male albino rats (8 per group) for three weeks, took body measurements at interval of three days, and collected the last five days urine and feces samples which were tested for nitrogen content using Kjeldahl method. Based on these trials, increase in growth rate of

differences in true digestability values between the test diets and control diets values were reported. The biological values (>75%) and net protein utilization (>65%) were reported above the recommended minimum values. The weights of organs (small intestine, pancreas, liver, and heart) of rats fed these foods were not higher than those fed the control diet. As a result, researchers recommended that cassava-soy products could be used for weaning foods, and processing could decrease the risk of cellular hypertrophy and hyperplasia of organs that could be caused by consumption of raw soybeans.

Maize-based transitional foods were also developed by Egounlety and colleagues (2002). They used maize meal or dehydrated fermented maize (ogi) flour fortified with soyabean, cowpea or groundbean tempe, with or without the addition of melon seeds. They measured the quality of the diets by feeding them to 40 rats in which measurements for protein efficiency ratio (PER), net protein ratio (NPR), true digestibility (TD), biological value (BV), and net protein utilization (NPU). Amino acid composition and amino acid scores were determined. Compared with the control (casein diet), the protein quality of the fortified weaning foods were reported to be similar. It was also reported that the amino acid profiles of maize and fermented maize (ogi) were improved by supplementation in bean tempe. Total amino acid content improved two to five folds in the bean fortified-maize and ogi transitional foods respectively compared to the unfortified maize and ogi. A good complementation of amino acids with 3-5 times increase with lysine in maize and 5-7 fold increase in fermented maize and two fold increase of methionine in maize and four fold increase in fermented maize was reported. Sensory evaluations were also conducted with ten nursing mothers and their children. Although mothers showed more preference for the casein product, mothers and their

children accepted foods prepared from these combinations. Due to their high protein quality, the tempe fortified weaning foods were recommended during 6-12 months.

Adelia and colleagues (1999) involved 40 toddlers (6-24 months) and their mothers to evaluate the acceptance of maize fortified with Ferrous Bisiglycinate (BIS) with or without antioxidant (BHA). The sensory assessment was part of a research project aimed to investigate the suitability of BIS for the use of corn in developing countries. Three samples used in the sensory evaluation were unfortified maize (sample A used as control), maize meal fortified with 30mg iron/kg (sample B), and sample C was further treated with 50ppm if the antioxidant butylated hydroxyanisole (BHA). To match the type of storage conditions that may be encountered in developing countries, the three samples were tested under different storage conditions for twenty days (sample A no heat treatment, samples B and C placed in 1 liter mason jars covered with loose fitting screw top lids stored at 30°C). After 20 days the samples were removed from the storage and frozen at -5°C until used. For sensory evaluation the three samples were prepared as porridge with the same quantities of maize, milk, margarine, and sugar. In order to keep the feeding experiment normal the first three feedings conducted during regular mealtime were used to familiarize children with the food and mothers with the assessment procedure. Later on toddlers and mothers tasted three samples per session where mothers indicated the toddlers degree of liking of the porridges based on a 9-point Hedonic scale. Mothers interpreted the non-verbal cues (turning the head away, spitting out the food, push away or reaching for spoon, accepting spoonfuls with mouth waiting open, etc.). Results indicated that in toddlers no significant differences were found among the porridges for overall liking. The mean for all the porridges were greater than 7.0 based on

the 9-point Hedonic scale. Parents preferred the control porridge followed by the BIS with BHS. As children's taste was not affected by the addition of iron or the antioxidant, the fortification of maize with iron was recommended as a potential strategy for preventing iron deficiency in developing countries.

In Peru, Kanashiro and colleagues (1991) used anthropological techniques to evaluate homemade transitional foods as part of a Dietary Management Program of Diarrhea (DMP). The different stages of the research included 1) information gathering to identify suitable foods, 2) formulation of adequate complementary foods based on nutrition principles, 3) recipe development through involvement of mothers, and 4) implementation of household trials. Mother's perception of appropriate foods to be fed to children during diarrhea was also gathered using open-ended questions. Based on mother's cultural definition of appropriate foods for diarrheal treatment, two food mixtures (wheat, peas, or faba beans, sugar, oil, and carrots; or potatoes, powdered milk, sugar, oil, and carrots) were identified. Eight to ten mothers in ten sites were provided with food to prepare three products; mothers were asked to use all of the ingredients and prepare appropriate food for their child. Common recipes mothers prepared were soups and puddings. The most energy dense recipe identified was called sweet Sanco (made of pre-toasted wheat flour, toasted pea or broad bean flour, carrots, brown sugar, and oil) with 233 kcal/100 g, followed by Sanco salty (178 kcal/100 g) which was made with the same ingredients as sweet Sanco except for the use of salt instead of brown sugar. The protein density for sweet Sanco and salty Sanco were 8.6 and 10.7% respectively. The addition of brown sugar in sweet Sanco increased the energy density but decreased the protein density. Most (81%) of the mothers preferred sweet Sanco and 88% of children

appeared to like it at first feeding. The concept of mixing wheat with pea, the use of carrots and sugar in children's food was reported to be a new experience for mothers, and the investigators recommended the use of the product.

Studies for the safe handling of complementary foods are equally important for promoting the health of children. Ehri and colleagues (2001) using Hazard Analysis and Critical Control Point (HACCP) techniques, identified processes and procedures that increased contamination hazards in transitional food preparation. Samples of foods at different stages of processing, preparation and storage were microbiologically analyzed. They reported that during cooking all foods attained temperatures high enough to destroy food borne pathogens. However, high risks of contamination were reported during storage at ambient temperatures, using insufficiently high temperature to reheat food, and by adding contaminated ingredients at a stage when no further heat treatment was applied. Noting the impact of unsafe environment, they concluded the need for promoting basic food safety principles in preparing complementary foods.

Energy and Nutrient Density of Transitional Foods

A transitional food is expected to provide 5-30% of the vitamin A, 20-45% of the protein, 50-80% of the thiamin, 50-60% of the riboflavin, 60% of the calcium, 85% of the zinc, and 100% of the iron for the child. Supplementary vitamins C, B_6 and B_{12} are not required due to adequate availability in breast milk unless the mother is malnourished (WHO, 1998).

Increasing the energy density of transitional foods suited for poor households is considered a practical challenge. WHO (1998) recommends that transitional foods meet the following energy needs based on specific age groups of children: 275 Kcal/d (6-8

months of age), 450 Kcal/d (9-11 months of age), and 750 kcal/d (12-23 months of age). The frequency of recommended feeding is also related to the energy density of complementary foods as presented in Table 2.1. Infants 6-8 months of age need to receive a minimum of 2-3 meals per day based on the energy density of the food in addition to breast milk. However recommendations on increased feeding frequency should also consider the adverse effect on reduced breast milk consumption (WHO, 1998).

Table 2.3 Minimum energy density (kcal/g) by number of meals

Age range (months)	2 Meals	3 Meals	4 Meals
6-8	0.88	0.59	0.44
9-11	1.16	0.77	0.51
12-23	1.48	0.98	0.74

Source Complementary Feeding Of Young Children In Developing Countries WHO, 1998, p168

Sensory Evaluation of Transitional Foods

Evaluation of organoleptic characteristics is recommended for promoting transitional foods (WHO, 1998). Factors considered to affect children's preferences for transitional foods include flavor, aroma, visual appearance and texture. In explaining food preference development, Birch (1999) wrote that food preferences are the result of the interaction between genetic predisposition and the eating environment. Children prefer sweet and salty tastes and reject sour and bitter tastes starting in early life. Children are considered neophobic to new foods, but are able to learn food preferences based on the eating environment that includes child feeding practices and food availability. Exposure to many foods in early life along with good parental modeling is

recommended to develop preference for a variety of food (Gerrish & Mennella, 2001; Mennella & Beauchamp, 1998).

Although young children have an innate ability to show sensory preferences for foods, their limited verbal ability and lack of comprehension makes sensory evaluation a challenge (Guinard, 2002). For example, understanding of scales and discrimination by sorting, which are necessary in sensory evaluation, are reported to develop gradually after three years of age. In younger children Guinard (2002) recommends that the caretakers interpret the child's food acceptance behavior and later taste and rate the food themselves. Involving caretakers in giving ratings is considered helpful in that acceptability to the caretaker will affect purchase intent of the product. For example, mothers in Guatemala related desired consistency of transitional foods based on the child's age and health status (Parker et al., 1998). Mothers suggested the use of thin consistency transitional foods for children less than one year old and for cough, fever or diarrhea, and thick consistency transitional foods for children older than one year and to stop diarrhea.

Most of the theoretical base for conducting sensory evaluations relates to healthy growing children. Studies on transitional food preferences in low-income households and with malnourished children are limited.

Types of Transitional Feeding Programs

In promoting transitional feeding programs, WHO (1998) recommended several points. These include the types of food to be used and the nutrition education and delivery systems to make sure children receive the intended transitional food properly. Careful transitional feeding intervention guidance is noted for its impact on improving

children's nutritional status while erroneous nutritional guidance is noted for serious side effects. Furthermore, appropriate transitional foods and feeding guidance are recommended to conform to local resources and beliefs. Examples of these programs are summarized in *Complementary Feeding of Young Children in Developing Countries*, which is the most comprehensive resource on aspects related to complementary/transitional foods (WHO, 1998). Two major approaches are described to enhance complementary foods: food-based intervention involved with the type of food or advice regarding feeding, and nutrition education related with the delivery of feeding guidelines to intended beneficiaries (WHO, 1998).

Food-based Interventions

Food-based interventions are described as those providing children with more access to appropriate transitional foods (WHO, 1998). Food-based interventions may involve universal or targeted distribution or marketing of complete food mixtures or distribution of food ingredients to be incorporated in household diets along with food production or pricing strategies. These strategies are believed to facilitate accessibility of ingredients to households. Following are specific examples of food-based interventions explained by the WHO (1998).

Centrally Processed Foods

To speed up home preparation of transitional foods, the mixtures are precooked in a central facility and fortified with vitamins and minerals if the foods are limited with nutrients. Centrally processed foods are marketed through commercial channels, health clinics or shops with or without subsidization. They are targeted to vulnerable groups

such as low-income families or undernourished children. While preparation convenience and provision of adequate nutrients are an advantage, packaging and distribution costs are considered disadvantageous.

Community Prepared Foods

Community prepared foods may also enhance transitional feeding (WHO, 1998). Existing community programs such as health centers, mothers' clubs or related organizations may prepare the food for on-site consumption or to be taken home. The community prepared food approach is noted for its capacity to stimulate small-scale food processing units and for reducing costs as compared with centrally processed foods. On the other hand, the need to have preparation centers and trained staff are considered as concerns for this approach.

Increased Availability of Selected Foods

Making selected foods more widely available is an alternative method to enhance the quality of transitional foods (WHO, 1998). Selective price subsides may allow milk or edible oils to be distributed through ration shops. Such programs are not necessarily aimed only at young children, but may be used with nutrition education messages to stress the use of such foods in the child's diet. These programs could be used in food pricing strategies to make access of transitional food items such as milk or edible oils to benefit children in low-income families.

Nutrition Education

Nutrition education involves communication activities aimed at achieving a voluntary change in nutrition behavior to improve nutritional status of a population (Andrien, 1994). The aim of nutrition education as a food-based program is to promote safe child feeding practices and to encourage mothers to improve traditional child feeding practices. Nutrition education messages are needed as a priority, regardless of the type of program to produce desired feeding behaviors. The education message may address a general aim such as frequency of feeding or promote specific recipes for a transitional food. In transmitting the nutrition education message it is suggested that traditional methods (such as home visits and cooking demonstrations) or social marketing methods (such as the triple A methods of assessment: assessment, analysis, action; the Precede-proceed model, the five step model: assessment, planning, development, implementation, and evaluation) could be employed (Andrien, 1994). Health centers, schools or community organizations such as women's clubs or religious organizations are considered important to promote nutrition education (WHO, 1998).

As a general recommendation to overcome malnutrition, UNICEF (1998) recommended several strategies to improve nutrition education: 1) Participation of households and communities, 2) Balance of bottom-up and top-down approach, 3) Use of an interdisciplinary team, 4) Research efforts, and 5) Support of government policies.

General Feeding Recommendation

Some of the general recommendations forr nutrition education include information on feeding behavior (desirable frequency of meals, proper utensils), of foods

to add to the diet for variety and adequacy, methods of food handling, and hygienic preparation and storage methods. Such guidelines are considered important because they provide the caregiver with important information in preparing complementary foods (WHO, 1998).

Specific Recipes

Dissemination of detailed information on recipes is another strategy noted to enhance complementary feeding efforts. This strategy is considered important in terms of providing increased accuracy about the amount and types of foods used to prepare transitional foods. However, it is also noted by professionals that the absence of a given ingredient may prevent a caregiver from using the transitional food mixture. Because of such challenges, interpersonal communication and demonstrations are needed (WHO, 1998).

Community-Based Nutrition Intervention Programs

The experiences of countries such as Bangladesh with community-based programs aimed at low-income households provided important information on improving child survival in a rural area (Bhuya and Chowdhury, 2002). The program included various components such as saving and credit schemes and training on skills development. A total of 13,549 children were included in the study. Based on comparisons of child mortality before and after community based programs, a 52% reduction of child mortality was reported among program participants compared with 31% in non-participants.

A transitional food project conducted in east Java and west Nusa during the late 1980s developed communication strategies to improve feeding practices of children less than two years of age (Manoff Group, 1991). To understand initial feeding practices, dietary assessment, a market survey of available foods, and factors affecting child feeding practices were gathered using anthropological research techniques. Based on identified problems, educational messages on breastfeeding, use of enriched recipes, and need for a fat source at six months of age were developed. Communication materials such as posters, counseling cards, and recipe leaflets were used by different groups, including trained health personnel, midwives, and local community leaders. Evaluation was conducted to measure effectiveness of communication activities. Results indicated that 50% of mothers in the project areas correctly recalled contents of mass media training materials, and 25% more remembered that they had seen or heard about it, but were not sure of the content. Mothers in program communities reported receiving information through different sources from those in control groups. Improved child feeding practices such as feeding of colostrum, proper preparation of infant food, and later introduction to adult food were reported in mothers who were reached with the weaning project.

The Dietary Management of Diarrhea (DMD) project was conducted in Ancash, Peru and in the state of Kwara in Nigeria during 1996-1998 (WHO, 1998). Based on results of the initial assessment study, community-based transitional feeding involving a home-prepared food recipe to complement breastfeeding for children during diarrheal episodes was promoted in Peru. However, in Nigeria the recipe was used as a transitional food for everyday feeding. In both places emphasis was given to energy density, frequency of feeding, protein adequacy, food hygiene, and nutrient density such as a plant

source of Vitamin A. The transitional food recipe in Peru was composed of pre-toasted wheat and pea flour, grated carrots, vegetable oil and sugar blended in a similar preparation as an adult snack (Kanashiro et al., 1991). The transitional food recipe in Nigeria consisted of fermented corn or sorghum paste, pre-toasted cowpea flour, palm oil and sugar cooked like the traditional porridge 'eko'. A five month pilot-intervention trial was employed to disseminate the enhanced recipes using mass media channels, interpersonal communication and professional training. Evaluation of the program in Peru was conducted on reported maternal knowledge, and trial and adoption of the recommended transitional food recipe. Results showed that 82% of mothers had heard about the recipe. Sixteen percent reported that they had prepared it once, and 12% reported that they intended to continue using it.

In Nigeria following eight weeks of pilot intervention and educational messages, samples of the transitional foods were given to mothers with children 4 to 24 months old (Guptill et al., 1993). Children's dietary intake, and mothers' knowledge was assessed in intervention and control groups before and after the program. Results from this trial showed that 57% of mothers in the intervention group knew the recipe, 48% tried it and 17% intended to use it in the future; mothers' adoption level of the recommended food was positively associated with their education level. In the control community, only 2% of mothers were aware of the recipe. These trials suggest the need for promoting nutrition intervention to all individuals in the community who provide direct care to children.

Summary

It is understood that children, even in low-income households in developing countries, are relatively healthy in the first four to six months of life because they are protected by breastfeeding. However, after about six months the need for appropriate transitional food becomes important to meet the child's increased energy needs. Although adequate transitional foods with continued breastfeeding is recommended, most children in developing countries are introduced to the regular household diet, which in most cases is crop-based with inadequate nutrients. As a result, researchers in several countries developed commercial transitional foods but these may not be accessible or affordable for low-income families in rural areas. There is a lack of adequate information on development of transitional foods using staple root crops such as enset, with a low protein content. If an acceptable and nutritionally adequate transitional food can be formulated from local food resources in the SNNPR, the information could be used to improve child feeding.

CHAPTER III

METHODOLOGY

The goal of this research was to develop transitional foods using local food resources for children of low-income households in southern Ethiopia. To achieve this goal, the study employed qualitative and quantitative approaches in collecting primary data. The study consists of four parts (see Table 3.1). Parts one and two were conducted to study the food consumption patterns and nutritional status of children in the study area. Parts three and four were conducted to formulate an enhanced transitional food using local foods. The last part was conducted to identify views of community members regarding children's nutritional status in the community. The following table summarizes different parts of the study and time of data collection.

Table 3.1 Time in which the study was conducted

Date	Description
Summer 2000	-Preliminary testing of instrument used for data collection (part 1) -Identification of possible ingredients for transitional food products.
Summer 2001	-Data collection on: food consumption, children's nutritional status (part 2), and views of government representatives (part 3).
Spring 2001	-Chemical analysis of food samples. -Formulation of transitional foods.
Summer 2001	-Preliminary testing of transitional foods (part 3).
Summer 2002	-Sensory evaluation (part 4)

Before conducting the study, approval was secured from the Oklahoma State University (OSU) Human Subjects Institutional Review Board (IRB) for all procedures of this research (Appendices A-C). A local advisor from the Awassa Agriculture College, Ethiopia also arranged for needed support in the study area (Appendix D). Additional approval was secured from the Bushulo Health Center (Appendix E), the Ministry of Agriculture and the Farmer's Association Office at the study area in Awassa, Ethiopia.

Research Setting

The study was conducted in Bushulo Health Center. The center is found in Awassa District, Sidama Zone, in Southern Ethiopia (Figure 3.1). The Awassa district with an area of 895.9 sq.km is inhabited by 319957 people and with a population density of 357 per sq.km (BOPED, 1996).

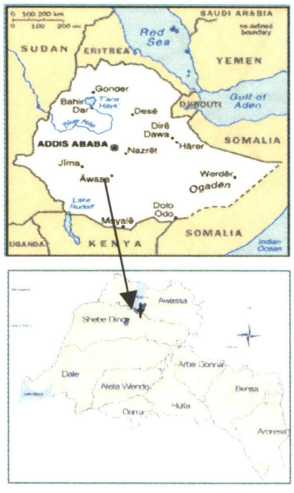

Figure 3.1 Location of the study area

The Busulo Health Center, about 7 km south of Awassa, has facilities for outpatients and inpatients from the surrounding community. The child-focused services provided by the health center staff include the outstation vaccination program, twins program, and child feeding program conducted by the nutrition unit. In the outstation vaccination program, parents bring their children to mobile vaccination units for vaccines such as measles and polio. These are children who do not normally come to the health center. The twins program is conducted within the health center's campus. In this program mothers are given a can of powdered milk and cereal powder every week to feed their twins. The nutrition unit is a newly established program within

the health center's campus. The main aim of the unit is to feed underweight children while demonstrating to mothers how to prepare better food for their children. Participant children are selected from outstation vaccination programs, from those admitted in the children's ward and from outpatients coming for physical examinations. The selection criterion for admitting children to the feeding program are being underweight and having obvious signs of malnutrition.

The child feeding program at the center attempts to involve mothers in preparing food items their children. One employed nutrition aide (a trained young rural woman) along with a health assistant, and a head nurse coordinate the program. The participating children along with their mothers are divided into 3 small groups (25-30 mothers come once a week on Mondays, Wednesdays or Thursdays). In each session 3 to 5 mothers take turns preparing the food for the group with the guidance of the nutrition aide.

The main food prepared is porridge made from corn, lentils and *fafa* (a premixed commercial product made of wheat, soy, pea, dried skimmed milk (DSM), vitamins and minerals). In addition, mothers are encouraged to bring whatever food they can from home (an egg, carrot or potato), which is added to the porridge to improve the nutritional value and to encourage mothers to contribute to the program.

For this study, an arrangement was made with Bushulo Health Center to use the facilities of the child feeding program. The Research and Extension office of the Awassa Agriculture College wrote a formal letter seeking the Center's approval for use of the nutrition unit (Appendix E). Besides having the required facility and subjects to participate in the study, the women and children who attended the programs were from low-income households in the area that met our selection criteria.

Pilot Study

In the summer of 2000 a pilot test of the study instrument was conducted to assess the food consumption of the study area. The instrument was a questionnaire inquiring into the nutritional practices of study participants. The questions were categorized in related sections for coherence. The researcher's major professor checked formulated questions for clarity, wording and sequence. The women's affairs department at the Ministry of Agriculture Bureau in Awassa and the Bushulo Health Center recommended a village with many poor households and large family size. As a result, a site called Finchawoha was selected and the local farmers' association office gave permission to conduct the study in the area. The local Ministry of Agriculture staff along with members of the farmers' association identified 12 women in the village who would participate in the pilot study.

The researcher asked the selected women for their willingness to participate in the pilot study. It was clearly explained that a person could refuse to participate in the study and no harm would follow. The questions were then administered in a one-on-one interview with each participant using a trained translator who could understand both Sidamigna, the local language of subjects in the research site, and Amharic, the language of the interviewer. At the end of the interview participants were given a bar of soap and some coffee to express our appreciation. Based on feedback from the pilot test of the interview questions, most open-ended questions were converted to closed-ended questions for better accuracy, but some open-ended questions were maintained (Appendix F).

Separate discussions were held with the Bushulo Health Center medical personnel and members of the farming community. They were asked if child malnutrition was a concern in the area.

Based on discussions with health professionals at Bushulo Health Center and farmers' representatives in the community, we were able to learn that children in the area were most affected by malnutrition. Mothers involved in the test indicated their children's poor nutritional status was caused by inadequate food availability. Reflecting her sorrow about children in the community one of the women stated, "If our children had the right food they would have been as healthy as urban children".

Household food availability was less than adequate. Corn and a root crop product called kocho were the major household foods. Mothers preferred corn over kocho for child feeding.

A shortage of food and frequent illness were raised repeatedly by community representatives, health professionals, and mothers. as causes Medical professional indicated they were concerned about severe infections such as vomiting and diarrhea which make the malnutrition worse. of poor child health They further associated children's poor nutritional status with the nutritional status of their mothers. For example, one of the mothers stated "In earlier days a pregnant woman would get a good diet that would result in having a healthy child, but not today."

In regards to community participation all involved reflected their interest in activities that would improve their children's nutritional status. At least one of the community representatives commented, "Many (researchers) have come and left after

collecting all the information they needed. Come back with something practical that would help our children".

Based on the results of this preliminary study, it was decided to carry out the study during the following year at the Bushulo Health Center nutrition unit. The unit had a weekly feeding program for mothers of severely malnourished children in the locality.

First Study

Purpose and Research Design

The primary purpose of study one was to obtain information regarding food production, consumption, and child feeding practices that would indicate the nutritional status of children in low-income households in the target population. The design for study one was descriptive involving qualitative and quantitative approaches.

Subjects

The target population for the first study was defined as low-income households with large family size and children under the age of five years in the Southern part of Ethiopia. A convenience sample of 71 children under five years old and their mothers who attended the child feeding service were involved in the study. It was believed that the group represented households who commonly consumed corn and Enset (a starchy root crop).

Because the study focused on children under the age of five years, the youngest child in each family was purposely selected to participate in an acceptability test of the prepared transitional foods. Though it was earlier planned to use 30-35 subjects, the

researcher in consultation with the local advisor decided to involve all of the 71 participants who attended the child feeding services of the unit. It was felt that not involving the remaining attendees could have negative implications for future collaborative work with the unit. In addition, it was believed that having more subjects could increase the validity of the data.

Data Collection

A questionnaire with a predefined set of nutrition and health related questions was developed to assess the food consumption and well being of children in the study area. A professor at Oklahoma State University checked the questionnaire for clarity, wording and sequence. It was then piloted in the research site with twelve women who were not part of the study. Participating women were given a bar of soap and coffee to express our appreciation.

Based on feedback from the pilot test most open-ended questions were converted to closed-ended questions to obtain concrete answers, but some open-ended questions were maintained. The final questionnaire included variables related to food production, food service, child feeding, and child morbidity and mortality, along with maternal views towards the health and development of children in the study area (Appendix F).

In the summer of 2001, data collection was completed from 71 mothers and their children with the help of trained interviewers and bilingual translators. Interviewers and translators were trained in the procedures to be followed for obtaining consistent answers. Specific procedures included making the respondents comfortable by greeting and explaining the purpose of the study. Specific roles of the interviewer in following the interview questions and the translator in transmitting the respondent's views without

interpretation were stressed. Interviewed mothers were each given a bar of soap and some transitional food in appreciation for their participation.

Data Analysis

The data for each subject were recorded on individual questionnaires which were identified with a number. Collected data was categorized, coded and entered into the SPSS software program (SPSS, 2001). Food consumption patterns in the study area were reported using descriptive statistics.

Second Study

Purpose and Research Design

The purpose of the second study was to assess the nutritional status of mothers and children in the target population. A descriptive design was used to explain the nutritional status of children.

Procedure

In order to get a realistic assessment of children's nutritional status, use of multiple indices of growth is recommended (Mascarenhas et al., 1998). In this study we measured anthropometric indicators of nutritional status such as height, weight, and arm circumference of children less than five years old. Mother's height and weight were recorded to calculate their BMI (wt/ht (kg/m^2)). Qualitative methods included the use of interview questions, which asked mothers their views of children's nutritional status.

An instrument with a headboard for measuring the height of mothers and children who could stand, and another device for measuring the length of children who could not

stand were made locally. The design was adapted from a photograph in a nutritional assessment book (Lee and Nieman, 1996). Arm circumference measurements were taken at the midpoint between the olecranon and acromion of the upper left arm using non-stretchable tape. Maternal weight was recorded using a balance beam scale. Children's weight was taken by placing them in a lined basket, and hanging it on a beam balance. Weight (adjusted for the basket and cloth) was recorded in kg. All body measurements taken were recorded in the form developed for this purpose (Appendix G).

Data Analysis

Data for this study were analyzed using Epi-Info 2000, a statistical program for public health professionals (CDC, 2000). *Weight-for-age*, *height-for-age*, *weight-for-height* were expressed in *Z-score* (Kassa et al., 2000). Mid-upper-arm circumference measures were expressed using cut off points (Gibson, 1990). Generated *Z-scores* were then entered into SPSS software computer program to run the descriptive statistics. Gender differences were checked using t-test. The *Z-scores* were compared with the WHO (1986) reference data. Mother's BMIs were calculated using height and weight data (Kassa et al., 2000). Growth charts were drawn using Epi-Info, 2000 software program (CDC, 2000).

Third Study

Purpose and Research Design

The primary aim of this study was to develop transitional foods using local food resources in southern Ethiopia and conduct acceptability test. The two transitional foods

(corn or kocho based) were formulated based on chemical analyses conducted at the University of Missouri, Columbia. Affective testing using the Central Location method (Stone and Sidel, 1993) was carried out for sensory evaluation of the transitional foods. Traditional corn and kocho porridges were used as controls. However due to the challenges to use a 2-product design in the research setting, panelists came to the center on two different days to test the samples. On day two the controls were evaluated, and on day one the experimental transitional foods were evaluated.

Selection of Food Samples

In this study rural women identified common staple food sources (corn, bulla and kocho) that were used in family diet and used in child feeding. Corn and kocho were supplemented with kidney bean to improve their protein quality and quantity [kocho (1.5g protein/100g), and corn (8g protein/100g)] as well as pumpkin to improve their carotene content. Likewise, chickpea, which is available but more expensive than kidney beans, was considered as an alternative legume to be used by mothers who could afford to buy it. The goal was to increase the nutrient content of the proposed transitional food to complement breast milk after six months of a child's life.

Food Processing and Chemical Analysis

The food ingredients were prepared according to the steps outlined in Appendix 6.1 prior to chemical analysis. Kidney beans and chickpeas were pre-cleaned, lightly roasted, de-hulled, and milled separately in a local flourmill. Corn was pre-cleaned, lightly roasted, de-hulled, and milled in local flourmills. Kocho and bulla were sun dried, crumbled and sieved to remove visible fibers. Pumpkin was peeled, grated and sun dried for easy transportation. Duplicate samples of the food ingredients were analyzed for

crude protein, amino acid profile, fat, and carotene by the Agricultural Experimental Station Chemical Laboratories, University of Missouri at Columbia. Results of the chemical analysis are presented in Tables 3.2 and 3.3 and Appendices H and I.

Table 3.2 Chemical composition of food ingredients

Food Item	Scientific Name	Crude Protein[1] (g/100g)	Crude Fat[2] (g/100g)	Carotene[3] (µg /100g)
Bulla	*Enset ventricosum*	0.96	0.20	32.10
Chick pea	*Cicer arienntinum*	24.15	5.40	242.15
Corn	*Zea mays*	8.20	3.37	139.45
Kidney bean	*Vicia faba*	28.30	1.20	<2.00
Kocho	*Enset ventricosum*	1.50	0.15	16.15
Pumpkin	*Cucurbita pepo*	7.14	2.40	11.25[4]

[1]Crude protein was estimated following Combustion Analysis (LECO) AOAC Official method 990, o3; 1995. [2]Crude Fat was estimated by Ether Extraction, AOAC Official Method 920 39(A), 1995. [3]Carotene was estimated following AOAC Official Method 970.64, 1995.[4]Measure indicated as milligram per 100gram sample.

Table 3.3 Essential amino acid (EAA) composition[1] (g/100) of selected food ingredients[2]

EAA	Bulla	Kocho	Corn	Chick pea	Kidney bean	Pumpkin
Histidine	0.02	0.03	0.28	0.65	0.88	0.15
Isoleucine	0.04	0.06	0.32	1.02	1.28	0.26
Leucine	0.08	0.11	1.03	1.82	2.26	0.34
Lysine	0.06	0.08	0.25	1.57	1.89	0.30
Methionine	0.02	0.03	0.16	0.35	0.33	0.09
Phenylalanine	0.05	0.07	0.43	1.48	1.57	0.25
Threonine	0.03	0.04	0.27	0.79	1.10	0.18
Tryptophan	0.04	0.04	0.07	0.31	0.30	0.07
Valine	0.06	0.08	0.43	1.11	1.47	0.57
Total	0.40	0.54	3.21	8.03	11.06	2.97

[1] EAA profile was made in accordance to AOAC Official Method 982: 30E(a,b,c,), CHP, 45. 3. 05.1995.
[2] Values are based on duplicate tests

Preliminary Testing of Transitional Foods

In summer of 2001 preliminary testing of four transitional foods: 1) Corn: chickpea: pumpkin, 2) Corn: kidney bean: pumpkin, 3) kocho: chickpea: pumpkin, and 4) kocho: kidney bean: pumpkin were tested with mothers attending the Bushulo Child feeding service. A local woman who assisted in translation facilitated the processing of

ingredients. A nutrition aid at the Bushulo health center and five other mothers prepared the transitional foods.

Mothers and their children (N=54) who attended the child feeding service and who came once a week on Mondays, Wednesdays, and Fridays were invited to participate in the sensory evaluation. All of the mothers agreed and were given coffee and a bar of soap in appreciation for their participation.

For the acceptability test a medium sized ladle (100 g) of prepared porridge was put in plastic bowls to be served for each child. Mothers were informed that they could give a second or third serving based on the child's desire. Consumption of an additional serving was considered as an indicator of acceptance. On the other hand, refusal or not finishing served food was considered an indicator of disliking. The child's preference for a given supplemental food and mother's opinion were recorded. Mothers were also asked to sample the porridge.

All of the sensory attributes for the preliminary test were favorably rated on a four point scale (Table 3.4). Mean scores and standard deviations ranged from 3.9 ± 0.3 to 4.0 ± 0.0 indicating good acceptability. There were no significance differences ($p > 0.05$) between the sensory attributes of the corn and kocho-based transitional foods. Although the preliminary tests of the four transitional foods were highly acceptable we decided to have controls (unfortified corn and kocho) and to delete the formulation with chickpea, as it is more expensive and less available in the locality. Hence the actual sensory evaluation was conducted in summer of 2002.

Table 3.4 Maternal ratings of the of the foods during pilot test

Sensory attribute	Hedonic Score[1]			
	Corn chickpea pumpkin (n=20)	Corn Kidney bean pumpkin (n=34)	Kocho chickpea pumpkin (n=31)	Kocho kidney bean: pumpkin (n=21)
Appearance	4.0 ± 0	4.0 ± 0	3.9± 0.4	3.9 ± 0.2
Smell	4.0 ± 0	3.9 ± .2	3.9 ± 0.2	3.9 ± 0.3
Taste	4.0 ± 0	4.0 ± 0	3.9 ± 0.3	3.9 ± 0.2
Consistency	4.0 ± 0	4.0 ± 0	3.9 ± 0.2	3.9 ± 0.3

[1] Foods were rated on a 4 point scale "4" was like very much, "3" like a little, "2" dislike a little, "1" dislike very much. Values are presented as mean ± standard deviation.

Selection and Training of Rural Food Processors

Three rural mothers from the study area were selected to process and prepare the transitional food for sensory evaluation in summer 2002. They were selected based on their earlier training and experiences as birth attendants, as recommended by the head nurse of the nutrition unit. The nature of the study and their expected service in food purchasing, processing, and preparation of the transitional food were explained to them. Oral consent was obtained from each woman and they were paid for their services based on local rates.

Processing of Food Samples

The women purchased the required food samples from a local market and processed the purchased food items (Figure 6.2). Corn and kidney beans were separately soaked in water for about six hours, drained and germinated at room temperature for 48 and 24 hours, respectively (Marero et al., 1998). Care was taken to handle the foods using

sanitary methods. The seeds were rinsed in cold water, partially sun dried and roasted until light brown. Kidney beans were de-hulled; and corn was lightly pounded to remove the seed coats and then milled in a community flourmill. Kocho was purchased from a local market. It was sun dried and the lumpy pieces were crumbled to make them powdery. The dried kocho was then passed through a sieve to remove visible fibers. Pumpkin was peeled, and chopped into smaller pieces of about 2 centimeters thick.

Formulation and Preparation of Transitional Food Mixtures

Two transitional food mixtures, namely corn:kidney bean:pumpkin (CBP) and kocho:kidney bean:pumpkin (KBP), were formulated. Kidney beans, which grow in the locality, were added to complement the low protein content and improve the amino acid balance of the commonly used staple crops, kocho and corn. Pumpkin was added to increase the vitamin A content. The addition of oil increased the energy density of the food without increasing the volume; however, only one teaspoon was added per 100 g of mixture because of the high cost of the oil.

Table 3.5 Amount and type of food items used in preparing the transitional foods

Food Item (s)	Corn (g)	Kocho (g)	Kidney beans (g)	Pumpkin (g)	Oil (g)
Corn: kidney beans: Pumpkin	40	-	30	250	4.0
Corn	100	-	-	-	-
Kocho: kidney beans: pumpkin	-	30	40	250	4.0
Kocho	100	-	-	-	-

Table 3.6 Nutrient densities of the transitional food mixtures as fed

Nutrient density	Legume fortified Corn	Traditional Corn	Legume fortified Kocho	Traditional Kocho
Energy density (Kcal/g wet weight)	0.48	0.53	0.42	0.44
Protein density (% of energy)	14.7	8.0	14.9	1.0
Vitamin A density (µg RAE/100g) wet weight	53.54	2.1	54.41	0.26

Sensory Evaluation

Selection and Training of Interviewers

Five technical staff of the Rural Development and Family Sciences Department of the Awassa College of Agriculture, Ethiopia along with five local translators were trained as enumerators to collect the sensory evaluation data. In order to facilitate the data collection procedure, the developed sensory evaluation questionnaire (Appendix J) was translated into the Amharic language, which was commonly understood by the data collection team.

Participants in the Sensory Evaluation

Two groups of non-literate mothers attending 'better child feeding classes" at the Bushulo Health Center in Sidama, Southern Ethiopia participated in the study. Group one included mothers whose children were fed in the nutrition unit once a week. Group two participants were selected from the twins program; mothers in this group received a can of powdered milk and a transitional food mixture biweekly to feed their twins in their own houses. After securing permission to participate in the study, 28 mother and child pairs from the nutrition program and 30 mother and child pairs from the twins program were selected to participate in the sensory evaluation. Children were eligible to participate in the feeding programs if they were malnourished. In addition to maternal interest to participate in the study, children were selected if they had a relatively healthy physical appearance and were consuming semi-solid or solid food. In order to determine which twin to involve, mothers were asked to identify the child who ate better and who they thought was healthier. Mothers in the twins program tested the Corn based foods, while those in the regular feeding program tested the Kocho based foods.

Prior to conducting the sensory evaluation, mothers were instructed to give their honest opinion after tasting the transitional food mixture and feeding it to their child. Each mother was given a pre-weighed portion of the transitional porridge to feed to her child and was asked to return any leftover food to the interviewers. Measured attributes were mother's preference, child's preference, after taste discomforts, and purchase intent. Mother's sensory evaluation and their judgment of their child's preference for the transitional food were recorded using the sensory evaluation questionnaire (Appendix J). In regard to the twins, only a single twin of each mother participated in the sensory

evaluation. This was done in order to reduce bias, which could be contributed by feeding their twins at the same time, one after another, or by different caretakers. For ethical reasons, the other twin and other children in the family were given a snack even though they did not participate in the study. At the end of the study each mother was given a bar of soap, feeding cups, plates and a snack as a token of appreciation.

Data Analysis

Variations in nutrient density of the two transitional food formulations and the sensory evaluation data were analyzed using descriptive statistics with the SPSS software program (SPSS, 2001). Affective testing for acceptance of the sensory attributes of the transitional foods for appearance, smell, taste, and consistency were rated using five point hedonic scale from which mean and standard deviation values were calculated. A one-way analysis of variance (ANOVA) was conducted to identify significant differences in the sensory attributes (appearance, smell, taste, and consistency) between legume fortified and traditional transitional foods..

Preparation of Alternative Foods

The food prepared for sensory evaluation was a soft porridge. In order to assess the potential of the two formulations to be used in feeding older children, an additional trial was conducted. Three women were asked to use the two transitional food mixtures (kocho:kidney bean:pumpkin and corn:kidney bean:pumpkin) to prepare different food products, that could be used for older children. As a result, women prepared an unleavened bread-type product called duame (a thicker mixture was wrapped in enset leaf and baked in direct fire), and a thin unleavened bread, which was baked on a hot plate. The women who prepared the food, along with four employees of the center who ate corn

and kocho were asked to taste the prepared food. All of them indicated that the taste of the food was pleasant and had a meat-like flavor.

Interviews with Government Representatives

The views of five professionals from the Regional Ministry of Agriculture at Awassa and five health professionals at the Bushulo Health Center were gathered using five open-ended interview questions (Appendix K). The major professor of the researcher at Oklahoma State University checked the interview questions for accuracy and clarity. Recruitment for the Ministry of Agriculture professionals was based on recommendations made from colleagues as to is most familiar with child nutrition issues in Ethiopia. Selected individuals were interviewed individually using the questionnaire with the open-ended questions. On the other hand, professionals at the Bushulo Health Center were interviewed in a group following the same open-ended questions provided for the Ministry of Agriculture professionals. The responses of the professionals from both organizations were tabulated to give us an understanding of their views to the five open-ended questions related to this study (Appendices L and M).

CHAPTER IV

FOOD CONSUMPTION, CHILD FEEDING PRACTICES AND MORTALITY OF UNDER FIVE CHILDREN IN LOW INCOME HOUSEHOLDS OF SOUTHERN ETHIOPIA

Abstract

Adequate food consumption has a positive impact on children's physical and cognitive development. Many children in developing countries including Ethiopia rarely receive adequate food, which makes them vulnerable to malnutrition. Interventions to alleviate such problems require empirical data on the local practices for food production and child feeding. The purpose of this study was to assess food consumption and child feeding practices of low-income households in Sidama, Southern Ethiopia. Individual interviews were conducted with a convenience sample of 71 low-income mothers with large families who had at least one under five year old attending a child feeding program. Mothers indicated they produced and consumed corn (85%) but few produced animals for food. Large family size and small land size both affected household food availability (97.2%). All newborn babies were breastfed. Children were weaned to a corn-based diet at about eight months (77.7%). More than 40% of mothers had experienced the death of a child, usually during the first year of life. Vomiting, diarrhea, and malaria were reported major causes of child death. Child feeding practices and disease conditions, contributed to poor nutritional status of children in the household and to mortality. These

findings suggest the need for a concerted effort in nutrition intervention applicable at a household level.

Introduction

Adequate food consumption is a key factor in child health, development and well being of any society. In areas where food supply is low such as in Sub-Saharan Africa and South Asia, national food availability is a major determinant of a child's nutritional status (Smith and Haddad, 2000). In Ethiopia, about 90% of households in rural areas face chronic or transitory food shortage that affects the nutritional status of young children (MOFED, 2002). A study on fluctuation of household food supply in Ethiopia indicated that children's nutritional status was better soon after harvest when there was more food in the house and was worse when the food stores in the house were finished (Branca et al., 1993). Pastore et al. (1993) showed that poor households in Ethiopia were affected by seasonal food shortages twice as severely as more wealthy households. In times of food shortage, milk and milk products were not usually available for children because livestock are sold as a survival strategy (Young and Jaspers, 1995). Such food shortages are critical for the health and development of children.

The nutritional status of children is not impaired by lack of food alone (Aboud and Alemu, 1995); rather, socio-cultural practices with specific regional variation play interrelated roles. Harmful traditional practices in Ethiopia include the avoidance of some foods (vegetables such as kale, milk and eggs) during pregnancy, provision of prelacteal fluids to newborn children or excessive breastfeeding duration without additional transitional food (CSA, 2001). The combined effect of food shortage and harmful traditional practices reduces the nutritional status of children.

Assessing food consumption and related practices affecting the nutritional status of children provides information that could be used in developing strategies for direct nutrition intervention at the household level. The purpose of this study was to describe the family food production, consumption and child mortality of under five year old children in poor households of southern Ethiopia.

Methodology

Research Setting and Site Selection

The study was conducted in Bushulo Health Center in Awassa district, Sidama zone, in Southern Ethiopia. The Awassa district, with an area of 895.9 sq km is inhabited by 319,957 people and has a population density of 357 per sq km (BOPED, 1996). The Bushulo Health Center was selected based on its outreach program for undernourished children attended by many of the low-income mothers and children in the surrounding community.

The Health Center, about 7 km south of Awassa, has facilities for outpatients and inpatients from the surrounding community. The child-focused services provided by the Health Center include the outstation vaccination program, twins program, and the under-nourished child feeding program conducted by the nutrition unit. In the outstation vaccination program parents bring their children to mobile units for vaccines such as measles and polio. These are children who do not normally come to the health center. The twins program is conducted within the health center's campus. In this program low-income mothers are given a can of powdered milk and cereal powder every week to feed their twins. The nutrition unit is a newly established program within the health center's

campus. The main aim of the unit is to feed underweight children while demonstrating to mothers how to prepare better infant food. Participant children are selected from outstation vaccination programs, from those admitted in the children's ward (inpatients) and from outpatients coming for physical examinations. The selection criteria for admitting children to the feeding program are being underweight and having obvious signs of malnutrition.

The child feeding program at the center requires mothers to take part in preparing infant foods. One employed nutrition aide (a trained young rural woman) along with a health assistant and a head nurse coordinate the program. The participant children along with their mothers are divided into three small groups (25-30 mothers come once a week on Mondays, Wednesdays or Thursdays). In each session three to five mothers take turns preparing the food for the group with the guidance of the nutrition aide.

The main food prepared is porridge made out of corn, lentil and *fafa* (precooked commercial cereal made from wheat, chick pea, powdered milk, and supplemented with minerals and vitamins). In addition, mothers are encouraged to add available food they bring from home (an egg, carrot or potato), which is added to the porridge to improve the nutritional value and to encourage mothers to contribute to the program.

Subjects

A convenience sample of 71 mother and child pairs who attended the child feeding service were involved in the study. After explaining the purpose of the study, mothers were asked if they were willing to participate. Mothers were assured that they could refuse to participate in the study and no harm would follow. The selection criteria used were being low-income with large family size and having at least one child below

five years of age who is underweight with sign of malnutrition. Mothers were given a bar of soap and dry transitional food mixture to prepare at their homes for their children in appreciation of their participation.

Before conducting this study in Ethiopia, approval was secured from the Oklahoma State University (OSU) Human Subjects Institutional Review Board (Appendix A). Furthermore, the Bushulo Health Center (Appendix E), the Ministry of Agriculture, and the Farmer's Association Office at the study site granted their approval to conduct this study.

Data Collection

A questionnaire with a predefined set of nutrition and health related questions was developed to assess the food consumption and well being of children in the study area. A professor at Oklahoma State University checked the questionnaire for clarity, wording and sequence. It was then piloted in the research site with twelve women who were not part of the study. Based on feedback from the pretest, most open-ended questions were converted to closed-ended questions to obtain concrete answers, but some open-ended questions were maintained. The final piloted questionnaire included questions related to food production, food service, child feeding, and child morbidity and mortality, along with maternal views about the health and development of children in the study area (Appendix F). Because most mothers did not read and write, data were collected using an individual interview following the structured questionnaire. Women were asked for permission to record their words.

Training of Interviewers

Rural development specialists of the Ministry of Agriculture assisted the researcher in conducting interviews. Because the subjects did not speak Amharic (the federal working language), translators who spoke Amharic and Sidamigna (the local language) fluently and who had completed high school (12^{th} grade) conducted the translation. Both interviewers and translators involved in this study were trained in the procedures to be followed for obtaining consistent answers. The training procedure included making the respondents comfortable by greeting and explaining the purpose of the study. Specific roles of the interviewer in following the interview questions and the translator in transmitting only the respondents' view were stressed. The interview process was rehearsed prior to the actual interview.

Data Analysis

Data for each subject were recoded on a questionnaire identified with a number. Collected data was categorized, coded and entered into the SPSS (SPSS, 2001) statistical analysis software program. Descriptive statistics were employed to report the data.

Results

Demographic Characteristics

Family size and maternal and child age are given in Table 4.1. The mean maternal age was 29 years (Table 4.1). Children's age was about 11/2 years. The average family size was seven with four children and one additional dependent. There were more female children (55%) than males (45%) in the study. Parental illiteracy was high as 90% of mothers and 55% of fathers were not able to read or write.

Food Production and Consumption

Family food production and utilization patterns are given in Table 4.2. The crop and animal production reflect the regular diet of surveyed households. The dominant crop produced was corn followed by enset (a starchy root crop), kidney beans and kale. Most of the respondents utilized corn for home consumption while a few (8.5%) sold some of their crop to earn income. Only 5.6% reported that they didn't grow corn. Production and consumption of animal products such as milk and eggs were minimal. A few (5 or 6) of the respondents raised cows for home consumption of milk and chickens for home consumption of eggs; only one family sold milk or eggs.

Most respondents felt that large family size and small land holdings affected food availability and consumption (Table 4.3). Other factors included high food prices, a lack of labor for farm work and shortage of rain.

Agriculture was reported as the main source of income while petty trading provided income for only 5.6% of the families (Table 4.1). Most respondents indicated that family income was less than enough and only 6% indicated that they had enough or more than enough for the family.

Food Service and Child Feeding Characteristics

Food service characteristics of the family are given in Table 4.4. The results indicated that the number of meals served in the day ranged from one to four although most mothers indicated that they served three meals a day. A few mothers mentioned that they provided a snack as a fourth meal for small children. The order of food service varied with local customs, but in most cases fathers and guests were served first followed by children and the mother.

Child feeding characteristics are given in Table 4.5. All of the mothers indicated the need for breast milk as the first food for newborn babies. The duration of breastfeeding extended up to 60 months with a majority of mothers continuing up to 36 months, and about one fourth (25%) breastfeeding from 37 to 60 months. Some mothers reported giving additional liquids such as boiled or unboiled water, cow's milk, or buttermilk. Most mothers added water to cow's milk (82%). A herbal drink named "*amessa*' and described as a green leaf extract; obtained by boiling the leaf with water was given to babies by 12 (17%) of the mothers.

The extended duration of breastfeeding affects the timing for the introduction of solid foods. Most infants were weaned gradually to solid foods (Table 4.5). Children were introduced to weaning foods, usually gruels or soft porridge made from corn, at 8.1 ± 5.7 months. Only a few mothers reported weaning their children to kocho. Most mothers fed their children, while a few siblings as young as 5 years of age shared child feeding responsibility.

Child Mortality

Tables 4.6 to 4.8 present data on child mortality. Among the interviewed mothers more than 42% had experienced the death of at least one child with one mother having lost five children. Nearly 20% reported the death of more than one child under the age of five years. Diseases with symptoms of vomiting, diarrhea, malaria, and *fincho* were reported to be the causes for child death. *Fincho* was described by mothers as a "head splitting disease" referring to the child's fontanel. Based on a physical observation of sick children carried by two mothers affected by *fincho,* the condition seems similar to severe marasmus where children were severely wasted.

Most of the mothers took their children to the clinic for treatment of illness while a few treated the children themselves. Medicinal herbs and drinks such as garlic, rue and animal bile were reported as treatments for malaria; and garlic, damakesse (a green leafy plant), and eucalyptus tree steam were used to treat common colds (Table 4.9).

Maternal Opinion on Services Promoting Nutritional Status

Most mothers believed that hospitals best promoted the nutritional status of children. However, 19 mothers indicated that hospital services should be enhanced (Table 4.10). Some mothers believed that provision of a clean water source and development projects such as credit services and dairy goat projects could improve the nutritional status of children.

Maternal opinions on nutrition related issues affecting the health of their children were assessed (Table 4.11). Most mothers disagreed with the statements that children in their community get adequate food and care, the family food is adequate for children, more children are an asset for the family, and child feeding training is not needed for parents. On the other hand, most mothers agreed with statements that food shortage is the only cause affecting the health of children, children were healthier in the past than recent periods, boys need better food than girls, and having transitional food is necessary for children.

Discussion

Demographic Characteristics

This explorative study was conducted in a rural setting with personal interviews, which is a practical way of getting primary data from a non-literate group (Creswell,

1994). In this study, the average family size was seven which is higher than the national average of 4.8 reported by the Ethiopian Central Statistical Authority (CSA, 2001). The parental illiteracy (90% of mothers and 55% of fathers) is also higher than the national average of 77% of females and 62% of males (CSA, 2001).

A relation between large family size and low literacy level in the Southern regions of Ethiopia was reported by Hogan and colleagues (1999). They identified literacy as one of the most important factors in reducing fertility through increased awareness and use of contraceptives. A study by the Ministry of Finance and Economic Development (MOFED, 2002) indicated that poverty indices increase with larger family size and decreased schooling of household heads.

Food Production and Consumption

Major staple foods produced are corn, kocho, kidney beans and kale, which are mostly used for home consumption. Few subjects in this study owned animals. As a result, consumption of animal source foods was very low with only a few subjects reporting the home consumption of milk and eggs on rare occasions. Most households did not own cattle or have cash to buy such commodities. Scherbaum (1996), in her study of kwashiorkor in west Wollega, Ethiopia, reported that more than 50% of mothers never offered milk to their children because they could not afford it.

Animal source foods are important sources of nutrients such as protein, iron, vitamin A, zinc, and vitamin B_{12} for physical and mental development of young children (Neumann et al., 2002). A related study in Botswana reported that ownership of cattle was the most important factor in determining children's nutritional status (Gobotswang, 1998). The low consumption of animal products such as milk and eggs and the presence

of corn or a root crop as a major staple food as observed in this study are critical nutritional concerns for young children who need adequate food with high biological value starting early in life.

In this study the main factors the mothers believed affected food availability were large family size and small land size. The view of mothers of the impact of large family size in our study was similar to a study in Ethiopia in which the number of under five siblings was related to the risk of malnutrition (Kinfu, 1999). Children with two or more under five siblings were reported to have 25% higher risk of malnutrition than their age mates with no young siblings. Possible competition of different aged siblings for food resources, and similar care of children regardless of age reduce the nutritional status of children. Manda (1999) noted that sibling competition for scarce food resources combined with lack of maternal attention due to subsequent pregnancies were responsible for reduced child survival.

Mother's reports that small land holdings affected household food availability were similar to a study by Hogan et al. (1999) who found that plots of land owned by households were inadequate to feed a family. Kinfu (1999) indicated that the risk of malnutrition in Ethiopia was 35% higher for children born to landless families than in those born to households with land holdings as low as 0.3 hectares. For families whose major income is based on agriculture, the limited production of cereals and root crops and the lack of animal source foods such as poultry and milk are major concerns in maintaining children's nutritional status.

Food Service and Child Feeding Characteristics

The order of food service is based on local custom. In some rural places the father and guests are served first, followed by children and finally the mother. Following this cultural practice by itself may not be a problem if there is adequate food. The obvious problem is that the person who is served last may have access to limited amounts of food.

All of the mothers in this study reported they breastfed their babies. This is in accordance with the national data indicating the universal practice of breastfeeding in Ethiopia (Abate et al., 1999; CSA, 2001). However, only 37% of babies less than six months old were exclusively breastfed, which is similar to the national data of 38% for 3-4 month old babies (CSA, 2001). In this study most mothers breastfed up to three years, and one-quarter extended up to the fifth year. Lindstrom & Berhanu (2000), using data from Ethiopia, reported a direct relation between breastfeeding beyond two years and a higher child mortality. The use of prelacteal fluids such as boiled or unboiled water, butter milk, *Ammesa,* reported in this study was more than three times higher than the level reported nationally (8% for water based liquids) for 6-9 month olds (CSA, 2001). Prelacteal fluids are known not only to replace the important breast milk, but also to increase the risk of diarrhea through contamination (Prasad and Costello, 1995). In this study 25% of mothers who experienced child death rated diarrhea as the primary cause of death.

Prior studies in Ethiopia have investigated the type and timing of weaning foods given to children. In western Ethiopia (Gamo-Gofa), about 66% of children aged 4-6 months old were exclusively breastfed and the rest were partially breastfed (Ketsela et al., 1990). Bekele and Bernahe (1998) reported that among mothers in Butajira (Ethiopia)

who breastfed their children, about 34% were breast fed beyond seven months, and 40% were reported to have been started on weaning food at the age of 4-6 months. Most of the children in this study were weaned to a corn-based diet and a few were weaned to a starchy root crop supporting related reports from other developing countries (Mbithi-Mwikya et al., 2002). Not only the late introduction but also the types of supplemental foods (Table 4.1) children consume are primary concerns. Cereal and root crop-based traditional weaning foods, which are common in most developing countries including Ethiopia, are known to be inadequate to promote growth. The very low level of protein, vitamin A, zinc, and iron present in most crop-based weaning foods is a serious problems because of the role these nutrients play in children's growth and development (Neumann et al., 2002).

Child Mortality

Child mortality, especially in the first five years of life, is an indicator of malnutrition. In this study more than 40% of mothers experienced the death of a child, often during the first year of life. The reported causes of child death such as vomiting, diarrhea, and measles imply the degree of malnutrition and un sanitary conditions leading to infectious diseases. Our results support the report by Muhe et al. (1991) in which the major causes of child death in Butajira (Ethiopia) were acute respiratory infection, measles and diarrhea. In describing causes of child death Scherbaum (1996) stated that because of inconsistent reporting, child death from malnutrition such as kwashiorkor may be reported to be due to pneumonia, tuberculosis, hypothermia, malaria, etc. We believe one of the major reported causes of child death, *fincho* described by mothers as "a head

splitting" condition, could be a high degree of malnutrition based on our observation of severe wastage and deterioration of children's bodies.

The associations between poverty and increased family size (MOFED, 2002) and closely spaced birth and mortality risks (Lindstrom and Berhanu, 2000) along with the lack of adequate health services could be among major problems contributing to high child mortality.

Conclusion and Recommendations

The current study showed the poor nutritional situation of low-income households in southern Ethiopia. Our data clearly showed the limited types of food production by involved households. The inadequate food production has major impact not only on the individual child, but also on the whole household and the society at large. The deaths of as many as up to five young children in a single household observed in this study suggest the need for increased support to alleviate child malnutrition. The resource limitations of families need to be addressed through selected livelihood and income support micro-credit projects such as the promotion of poultry, dairy goats, vegetable gardening, etc. Subjects of this study also expressed the need for such projects. Such food-based interventions not only contribute additional income but also improve the quality of the family diet particularly for children under five years of age. At the same time, providing participatory training where children's caretakers have an active role in discussing critical issues such as the harm of prelacteal fluids, the need for timely and adequate transitional food, and improved hygienic practices for control of infectious disease is vital. In this regard, the nutrition unit at Bushulo Health center has initiated an important approach to involve participatory training and demonstrating better child feeding practices to mothers.

However, there is a need to evaluate the impact of the program for much improved service based on initial objectives. A possible way to evaluate whether the program has met its objectives could be through monitoring the weight gain of involved children and knowledge acquisition of mothers using pre-test and post-test techniques. This study has indicated the inadequate food production and consumption and high child mortality among study participants. However, further in-depth study is needed to understand the underlying factors and to recommend problem-targeted strategies for timely intervention.

Table 4.1 Demographic characteristics of the respondents attending the Bushulo Health Center child feeding service (N = 71)

Characteristics	Mean ± SD	Range
Age		
Maternal (years)	28.8 ± 5.7	16-43
Children (months)	19.3 ± 13.3	4-60
Family size	7.0 ± 2.8	3-18
Dependents	0.9 ± 1.9	0-9
Characteristic	**N**	**%**
Gender of children		
Female	39	54.9
Male	32	45.1
Parental education level		
Father		
Not read or write	39	54.9
Able to read and write	12	16.9
Elementary school	14	19.7
High school	6	8.7
Mother		
Not read or write	64	90.1
Able to read and write	4	5.6
Elementary school	2	2.8
High school	1	1.4
Reported source of income		
Agriculture	40	56.3
Mixed income	27	38.0
Petty trade	4	5.6
Maternal opinion on adequacy of income		
Less than enough	44	62.0
Barely enough	23	32.4
Enough	3	4.2
More than enough	1	1.4

Table 4.2 Family food production and utilization of study participants (N = 71)

Foods	Home consumption		Partial sell		Do not grow/ own	
	N	%	N	%	N	%
Crop						
Corn	61	85.9	6	8.5	4	5.6
Enset[1]	55	77.5	4	5.6	12	16.9
Kidney beans	31	43.7	1	1.4	39	54.9
Kale	21	29.6	1	1.4	49	69.0
Green pepper	7	9.9	0	0	64	90.1
Avocado	6	8.5	0	0	65	91.5
Potatoes	5	7.0	1	1.4	65	91.5
Banana	5	7.0	2	2.8	64	90.1
Cabbage	3	4.2	0	0	68	95.8
Teff[2]	2	2.8	1	1.4	67	94.4
Cauliflower	2	2.8	0	0	69	97.2
Sweet potatoes	1	1.4	0	0	70	98.6
Chat[3]	0	0	2	2.8	69	97.2
Animals & products						
Milk	6	8.5	1	1.4	64	90.1
Chicken	0	0	4	5.6	67	94.4
Eggs	5	7.0	1	1.4	65	91.5
Butter	1	1.4	3	4.2	67	94.4
Calf	1	1.4	0	0	70	98.6
Beef	1	1.4	0	0	70	98.6

[1]Enset (*Enset ventricosum*): starchy root crop also named false banana.
[2]Teff (*Eragrostis tef*): Small cereal grain made into leavened thin flat bread.
[3]Chat: a green leaf chewed as a stimulant.

Table 4.3 Respondent's perception of factors affecting household food availability

Mentioned factors	N	%
Large family size	69	97.2
Small land size	69	97.2
High food prices	13	18.3
Lack of labor	4	5.6
Lack of rain	3	4.2

Table 4.4 Frequency and order of meal service in the farm families included in the study (N = 71)

Number of meals served in the day	N	%
Once	10	14.1
Two times	16	22.5
Three times	41	57.7
Four times	4	5.6

Order of service	First		Second		Third		Eat together	
	N	%	N	%	N	%	N	%
Father	64	90.1	1	1.4	0	0	5	7.0
Guest	65	91.5	1	1.4	0	0	5	7.0
Children	1	1.4	64	90.1	0	0	5	7.0
Mother	1	1.4	3	4.2	62	87.3	5	7.0

Table 4.5 Child feeding characteristics of study participants (N = 71)

Characteristics	N	%
First food		
Breast milk	71	100.0
Duration of breastfeeding in (months)		
Birth-12	2	2.8
13-24	22	31.0
25-36	30	42.3
37-60	17	23.9
Additional fluids		
Boiled water	15	21.1
Unboiled water	15	21.1
Amessa[1]	12	16.9
Cow's milk	2	2.8
Buttermilk	1	1.4
Add water to cow's milk?		
Yes	58	81.7
No	13	18.3
Weaning process		
Gradual	53	74.6
Abrupt	17	23.9
Type of weaning food		
Corn gruel & porridge	47	64.8
Corn bread	9	12.7
Kocho gruel & porridge	4	5.6
Other	11	15.5
Who feeds the child?		
Mother	69	97.2
Sibling		
Age: 5-10y	4	5.6
11-15y	8	11.3
Grandmother	1	1.4

[1]Amessa: a green leaf extract given to children to clean the gastrointestinal system.

Table 4.6 Number of mother's children who had died

Number of children who died	N	%
None	41	57.7
One child	16	22.5
Two children	6	8.5
Three children	5	7.0
Four children	2	2.8
Five children	1	1.4

Table 4.7 Ages of under five year old children who died (n = 27)

Age	N	%
< 1 year	9	33.3
1-2 years	3	11.1
2-3 years	2	7.5
3-4 years	1	3.7
4-5 years	1	3.7
> 1 death	11	40.7

Table 4.8 Reported causes of death of children under 5 years old in the study (n = 28)

Causes of death	N	%
Vomiting and diarrhea	7	25.0
Fincho	5	17.9
Malaria	4	14.3
Measles	2	7.1
Other (respiratory, puffy face)	10	35.7

[1]*Fincho*: disease that leads the child to severe weight loss similar with protein energy malnutrition, "mothers refer to it as head splitting which may mean open fontanel"

Table 4.9 Reported medicinal herbs and drinks used to treat children (n = 71)

Suggested medicinal items	N	%	Treatment Purpose
Garlic	50	70.4	Common cold, malaria
Ginger	32	45.7	For treating stomach cramps
Damakesse[1]	23	32.4	For flu type symptoms
Rue[2]	18	25.4	For stomach cramps and malaria
Amessa[3]	11	15.4	For cleaning the stomach
Bean water	3	4.2	For measles
Animal bile	2	2.8	For treating malaria
Hot ash	2	2.8	For sudden stomach ache
Eucalyptus leaves	1	1.4	For common cold

[1]Damakese: green leaf squeezed and rubbed over the body for flu like symptom.
[2]Rue (*Rutta graveolens* L.): green herb chewed for stomach cramps.
[3]Amessa: a green leaf extract given to children to cleanse the gastro intestinal system.

Table 4.10 Maternal opinion of services to promote the children's nutritional status (n=71)

Suggested services	Existing services		Needed services	
	N	%	N	%
Hospital	68	95.8	19	26.8
School	1	1.4	9	12.7
Church	1	1.4	-	-
Other	1	1.4	-	-
Development projects	-	-	16	22.7
Clean water source	-	-	10	14.1

Table 4.11Maternal opinion1 on nutrition issues related with growth and development of children

When I think about the health and development of our children:	Agree or Strongly Agree		Disagree or Strongly Disagree	
	N	%	N	%
Children in our community get adequate food and care	1	1.4	70	98.6
The family's food is adequate for children	2	2.8	69	97.2
More children are an asset for the family	11	15.5	60	84.5
Child feeding training is not needed for parents	21	29.6	50	70.4
Food shortage is the only cause affecting the health of children	40	56.3	31	43.7
Children in earlier days were healthier than children in recent days	47	66.2	24	33.8
Boys need better food than girls	57	80.3	14	19.7
Having weaning and transitional food is necessary for children	65	91.5	6	8.5

[1]Maternal opinion was measured using a 4-point scale (1 = strongly disagree, 4 = strongly agree).

CHAPTER V

A NUTRITIONAL ASSESSMENT OF MOTHER AND CHILD PAIRS IN LOW INCOME HOUSEHOLDS OF SIDAMA ZONE, SOUTHERN ETHIOPIA

Abstract

Socioeconomic deprivation and inadequate dietary intake retards the growth and development of children. This study assessed the nutritional status of 71 low-income mothers and children under the age of five who attended the nutrition service of Busshello Health Center in Sidama, Southern Ethiopia. Children's height, weight, midarm circumference, and mother's height, and weight were measured. Data were analyzed by using the Epi-Info, 2000 software program. The prevalence of mild (43.7%) and significant (45.1%) underweight and mild (47.9%) and significant (43.9%) stunting indicated severe childhood malnutrition. Only 3 children were severely wasted but half were mildly wasted. Mid upper arm circumference showed 70% of children were malnourished and 15% were at risk of malnutrition. All measures indicated most children were below the 5^{th} percentile of the reference population. Maternal BMI indicated 56% of mothers were within normal BMI ranges (19.8-26) in adult women of reproductive ages. The high rate of pediatric malnutrition reported in this study suggests the need for immediate nutrition intervention to meet nutritional needs of under five children and reduce future risks associated with malnutrition.

Introduction

Improving the nutritional status of children to support appropriate growth and development is becoming the main objective of primary health care in many countries including Ethiopia. Children with a history of malnutrition show limited physical and cognitive development; such children are stunted and have little chance to attain their full growth potential if left in the same environment (Scott et al., 1999). Stunting is a reflection of the socio-economic environment of children (Kinfu, 1999). A recent national survey reported more than half (52%) of Ethiopian children under five years of age were stunted and more than one in four (26%) were severely stunted (CSA, 2001). The survey also showed that more than three in ten women had a BMI $\leq$18.5 indicating a serious energy deficiency among women (CSA, 2001).

The nutritional status of children is assessed using anthropometry because these methods are inexpensive, non-invasive and universally applicable (Gibson, 1990). The assessment of nutritional status using anthropometric measures depends on the concept that in a well nourished population the distribution of children's height and weight at a defined age will approximately follow a normal distribution (CSA, 1999). Based on the understanding that all people have similar genetic potential for growth (Habicht et al. 1974), the World Health Organization has recommended use of the International Reference Population defined by the U.S. National Center for Health Statistics for comparative assessment of nutritional status (WHO, 1986).

The combined use of basic nutritional anthropometric measurements such as weight, height, body circumference measures, and skin fold measurements give *indices,* which are necessary for interpretation of body measurements (Zemel et al., 1997).

Recommended indices used to assess nutritional status include body mass index (kg/ht (m^2)), weight-for-age, height-for-age or weight-for-height. When using these indices children who are less than two standard deviations (SD) (*Z-scores*) from the reference median are considered to be malnourished and those below three standard deviations from the reference population are severely malnourished (Pelletier et al., 1994).

Efforts to reduce child malnutrition need local data to account for regional variations in food habits and child feeding practices (Hailu & Tessema, 1997). Children in low-income households of southern Ethiopia are weaned to a staple diet of corn or kocho, a starch processed from a root crop called enset. Enset does not provide adequate protein for children. Nutritional assessment of children along with other family members provides information needed for nutrition intervention and planning. To determine the nutritional status of under five children and their mothers in the community we used internationally accepted indices such as weight-for-age, weight-for -length, and height-for- age measures. The purpose of this study was thus to evaluate the nutritional status of mothers and children in the low-income households of Sidama zone using nutritional anthropometric measurements.

Methodology

In order to obtain a realistic assessment of children's nutritional status, multiple indices of growth are recommended (Zetlin et al., 1992) In this study in the Sidama zone of Southern Ethiopia, anthropometric indicators of nutritional status (height, weight, and arm circumference) of children less than five years old and height and weight of others were measured.

Subjects for this study were selected among low-income households of large family size having at least one child less than five years old who attended the child feeding service of Bushulo clinic. The main aims of the nutrition unit at Bushulo Health Center are feeding underweight children, demonstrating to mothers how to prepare better infant food, and providing vaccinations to children. Children were selected from outstation vaccination programs, from those admitted in the children's ward (inpatients) and from outpatients coming for physical examinations. The selection criterion for admitting children to the feeding program was being underweight. Seventy-one purposely-selected low-income mothers and their youngest under five-year-old child participated in the study.

Procedure

Children's weight was taken with minimal clothing by placing them in a lined basket and hanging it on a beam balance(weight adjusted). Weight was recorded to the nearest 0.1 kg. Children who were uncooperative were measured in their mother's arms, and adjustment was made by subtracting maternal weight. The scale was regularly calibrated for accuracy using a known weight. Standing height was obtained from children who were able to walk and who were over two years. Recumbent length was obtained from children who were not able to stand. Both height and recumbent length were recorded to the nearest 0.1 cm. Maternal weight was measured to the nearest 100 g using a calibrated scale, and their height was measured to the nearest 0.1 cm using a locally designed stadiometer. An instrument with a headboard for measuring standing height and another device for measuring recumbent length were designed by a local carpenter using photographs from a nutrition textbook (Lee and Nieman, 1996).

Children's arm circumference was measured at the midpoint between the olecranon and acromion of the upper left arm to the nearest 0.1 cm using a non-stretchable tape measure. Mother's height (cm) and weight (kg) were recorded to calculate their BMI that was later used to classify mothers in to different nutritional status categories (IOM. 1990). All body measurements taken were recorded on the form developed for this purpose (Appendix G).

Data analysis

Data for this study were analyzed using Epi-Info 2000, a statistical program for public health professionals (CDC, 2000). *Weight-for-age*, *height-for-age*, *weight-for-height* were expressed in *Z-score* (Kassa et al., 2000). Mid-upper-arm circumference measures were expressed using cut off points (Gibson, 1990). Generated *Z-score* values were then entered into SPSS software computer program to run the descriptive statistics. Gender differences were analyzed using the t-test. The *Z-scores* were compared with the reference data by selecting the 1978 reference option on the Epi-info screen (WHO, 1986). In defining the nutritional status for the three indices Z-scores $\leq$ -2.00 was severely malnourished, -1.99 to -1.00 malnourished, and >-1 normal. Mother's BMIs were calculated using height and weight data, and compared with defined BMI cutoffs (IOM, 1990). Growth charts were drawn using Epi-Info, 2000 software program (CDC, 2000).

Results

Demographic Characteristics

Seventy-one mothers and their children who were under five year old participated in this study. The mean maternal age was 29 years (Table 5.1). The children's mean age was about 11/2 years. The average family size was about 7 persons. There were more female (55%) than male (45%) children in the study. Most of the mothers and half of the fathers were not able to read or write. The main source of family income was agriculture supplemented with mixed income and petty trading.

Anthropometric Data

Table 5.2 shows the severity of child malnutrition in the study area based on *Z-scores* for *weight-for-age height-for-age, weight-for-height*, and arm circumference measures. Nearly 90% of children were underweight. Only eight children had normal *weight-for-age* (*Z-score* >-1.0). Figure 5.1 shows the prevalence of underweight for male and female children; most children were below the 5^{th} percentile of the reference population (de Onis et al., 1996).

Table 5.2 shows the prevalence of stunting in children. More than 90% of children were stunted to some degree. There was no significant gender difference in the prevalence of stunting. Figure 5.2 displays the prevalence of stunting by gender; most of male and female children were below the 5^{th} percentile of the reference population (de Onis et al., 1996).

The relationship between weight and current stature of a person provides important information in differentiating whether wasting, stunting, or both have occurred.

About half of the children in this study were mildly wasted and three were severely wasted. There was a significant gender difference observed in weight-for-height Z-scores ($P < 0.05$). Males were thinner than females (mean ± S.D. *weight-for-height Z-score* –1.4 ± 1.1 for males and –0.6 ± 1.4 for females).

Based on a middle upper arm circumference measure, 70% of children in the study area were malnourished (MUAC < 12.5 cm), and 11 and more children (15%) were at risk of malnutrition (MUAC 12.51 to 13.49 cm) (Table 5.3). There was a significant gender difference (p< 0. 05); males had smaller arm circumference measures than females (mean *Z-score* males –3.0 ± 1.0 and females –2.6 ± 1.0).

The average BMI of mothers was 20.2 ± 2.3. Their average weight was 48.5 ± 6.5 kg, and average height was 155 ± 7.1 cm, which was comparable to the national data of 156 cm. In adult women of reproductive age, BMIs <19.8 indicate underweight (IOM, 1990). In this study more than 40% of the mothers were underweight and 56% had normal weight. None of the mothers were in overweight or obese categories (Table 5.4).

Maternal Satisfaction Towards Children's Growth

The majority of mothers (59%) believed that their children appeared physically healthy (Table 5.5) and about half believed that their children got sick less often than other children. When asked if they were satisfied with the development of their children, more than 50% of the mothers indicated their satisfaction.

Discussion

The study showed that 45% of children were severely underweight, 48% were severely stunted and 4% were severely wasted which is consistent with previous studies

in Ethiopia (Hailu and Tessema, 1997). When 20 to 40% of a population is underweight the population is moderately malnourished and if more than 40% of the population is underweight, a severe problem exists in the community (WHO, 1986). The severity of underweight observed in this study indicates the magnitude of child malnutrition in the area. Compared with the national data in Ethiopia (47.2% with a *Z-score* less than -2), the prevalence of underweight (45.1%) in this clinic sample indicates a severity of malnutrition among children that is comparable to the national data.

In addition, a 25-50% rate of stunting in children is regarded as an indicator of a moderate rate of malnutrition in a population (WHO, 1986). The overall stunting (43.7%) observed in this study is slightly lower than the Ethiopian average of 47.2%, but high enough to be considered a major problem (CSA, 2001). The prevalence of stunting seen in this study agrees with previous reports indicating stunting in under five children in Ethiopian to be the highest in any African country (UNICEF, 2002). Stunting in a community indicates a long-term dietary inadequacy or repeated episodes of illness reflecting socioeconomic deprivation which can lead to reduced adult size and later work capacity (Rush, 2000). Although smallness could be genetic, it is also associated with small pelvic structure and pregnancy complications. Short women are more likely to deliver infants with low birth weights and childhood stunting, increasing the risk of malnutrition in future generations (Kraisid and Gillespie, 1999). The average height of mothers (155 cm) was slightly less than the national reported figure (156 cm) for Ethiopian women (CSA, 2001). However, compared with the international data (for example, the average height of Canadian women was 163 cm (Gilmore, 1999)), women in this study were much shorter, indicating the risk of mentioned delivery complications.

Considering the fact that these children were receiving additional food by the nutrition unit, data from this study suggests that conditions in the Sidama region have reached the point where wasting is a serious problem. About half of the children who attended the nutrition unit were moderately wasted, indicating an acute nutritional problem requiring nutrition intervention (WHO, 2002). The mid upper arm circumference, a composite measure of muscle and fat stores, also showed that majority of children in this study were malnourished. Based on the duration of breastfeeding in this area, malnutrition could have started when children in the study area were introduced to the corn and root crop based family diet which fails to provide adequate nutrition to supplement breast milk.

Based on BMIs, more than 50% of the mothers in our study appear to be in good nutritional status. This is in agreement with a study in the eastern part of Ethiopia (IOM, 1990). Lindtjorn and Alemu (1997) examined how anthropometric measurements were correlated among 1147 household members in Elka village in the Ethiopian Rift Valley. The study showed poor correlation in nutritional status among household members. In the present study, the normal nutritional status of the majority of mothers and poor status of their children may indicate that children's nutritional status may have been affected by factors other than inadequate nutrition, such as the lack of medical services. Although medical and related services are essential for every member of the family including mothers, the impact could be greater in young children who could easily be affected by common childhood diseases such as measles. Getaneh and colleagues (1998) used a multiple logistic regression analysis to show strong associations between protein energy

malnutrition in under five children and poor housing conditions, lack of availability of latrines, unprotected water source, attacks of pertussis and incomplete immunization.

The lack of conformity between the mother's views of the nutritional status of her child and measures of malnutrition has implications for nutrition intervention. Though more than 50% of mothers in this study believed their children appeared physically healthy and were satisfied with the development of their children, our results did not support this view of the children's nutritional status. Christiaensen and Alderman (2001) using the 1998 Ethiopian Health and Nutrition Survey data showed that mothers correctly evaluated the growth performance of their child in only 53.7% of all cases. They further reported "when a mother considers the growth of her child normal, it is about equally likely to be stunted as it is not to be stunted" (Christiaensen and Alderman, 2001, p 8). They further noted that this finding should not totally imply that mothers with malnourished children are not aware of proper childcare practices. Rather nutrition and health education programs need to collaborate with mothers and community members who could improve the nutritional status of the children.

Limitations of the Study

The total sample size of 71 mother and child pairs is adequate to give a general understanding about the nutritional status of children. However it was not possible to identify the age group most affected by malnutrition because we were not able to stratify the children's age group. A general misclassification of children's nutritional status could occur due to measurement and recording error. Furthermore maternal views regarding the nutritional status of their children could have been underreported due to social desirability and community norms.

Conclusions and Recommendations

The assessment of children's nutritional status is important to monitor their growth and development. No single method of nutritional assessment can accurately identify nutritional conditions, rather the combined use of different methods is recommended to define the nutritional status of a population (Mascarenhas et al., 1998). In this study, all of the anthropometric measurements used reflected the poor nutritional status of under five children in the study sample. These children were not remarkably different than the national data with respect to stunting or underweight.

The nutritional status of children in this study is not satisfactory. The high prevalence of stunting and underweight observed suggests the need for child-targeted integrated programs employing community participation for sustainable impact. For example a child-targeted program would imply the need for such programs to contribute to the health and development of the child in direct or indirect ways. Integrated program such as the one these families attend implies the need for a coordinated service that could improve diet and medical services for children. Involving community participation encourages long lasting results; families or groups in a community are involved in development projects for problem solving and decision-making. Community participation in promoting development projects is considered important for empowering community members and assuring sustainability of intervention projects (Andrien, 1994).

More attention is needed to improve children's nutritional status through integrated programs focusing on increased food security, poverty reduction, nutrition, and health education. To evaluate if these programs achieved their goals, defined outcome evaluation could be used. Pre-intervention and post intervention differences on selected

variables such as weight gain of children, frequency of child illness, maternal knowledge on child feeding and health could be measured.

The relatively normal BMIs of majority of mothers and their view of a healthy child might indicate the need for nutrition education communication strategies to be used in extension programs. On the other hand the short maternal height combined with more than 40% of underweight observed in mothers also indicate the poor nutritional status of mothers. While the specific nutrition education messages need to be defined based on situation analysis of the community, the need for timely introduction of adequate transitional foods for children and a way to increase such food resources (through vegetable gardening or poultry) would be beneficial.

Table 5.1 Demographic characteristics of the respondents who participated in the nutritional assessment study (n=71)

Characteristics	Mean ± SD	Range
Age		
Maternal (years)	28.8 ± 5.7	16-43
Children (months)	19.3 ± 13.3	4-60
Family size	7.0 ± 2.8	3-18
Characteristic	**N**	**%**
Gender of children		
Female	39	54.9
Male	32	45.1
Parental education level		
Father		
Not read or write	39	54.9
Able to read and write	12	16.9
Elementary school	14	19.7
High school	6	8.7
Mother		
Not read or write	64	90.1
Able to read and write	4	5.6
Elementary school	2	2.8
High school	1	1.4
Reported source of income		
Agriculture	40	56.3
Mixed income	27	38.0
Petty trade	4	5.6

Table 5.2 Z-score distribution by weight for length, weight for age, and height for age (n=71)

Nutritional status	Z-scores	Weight for age		Height for age		Weight for length	
		N	%	N	%	N	%
Severely malnourished	<-2.00	32	45.1	34	47.9	3	4.2
Malnourished	-1.99 to –1.00	31	43.7	31	43.7	36	50.7
Normal	>-1.00	8	11.3	6	8.5	32	45.1

Table 5.3 Middle upper arm circumference measures of children (n=71)

Nutritional status	Cut off points	N	%
Malnourished	≤12.5	50	70.4
At risk	12.51- 13.49	11	15.5
Normal	≥13.5	10	14.1

Table 5.4 Body mass index (BMI) of mothers (n=71)

BMI	Description	N	%
<19.8	Underweight	31	43.7
19.80 - 26	Normal weight	40	56.3
> 26 - 29	Overweight	0	0
> 29	Obese	0	0

Figure 5.1 Weight for age graph of all female children

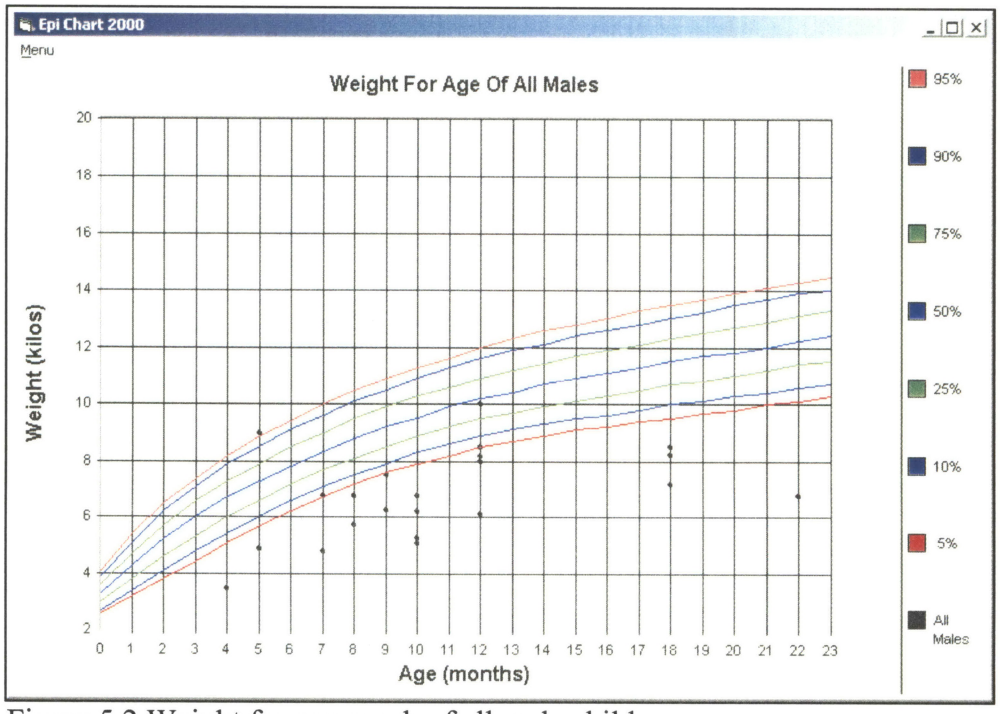

Figure 5.2 Weight for age graph of all male children

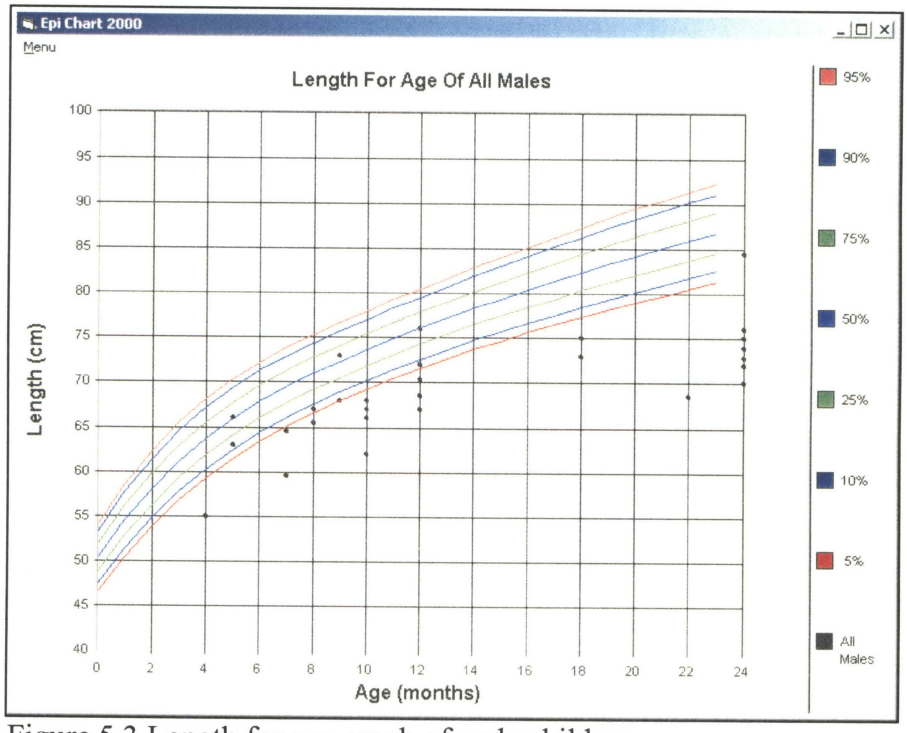

Figure 5.3 Length for age graph of male children

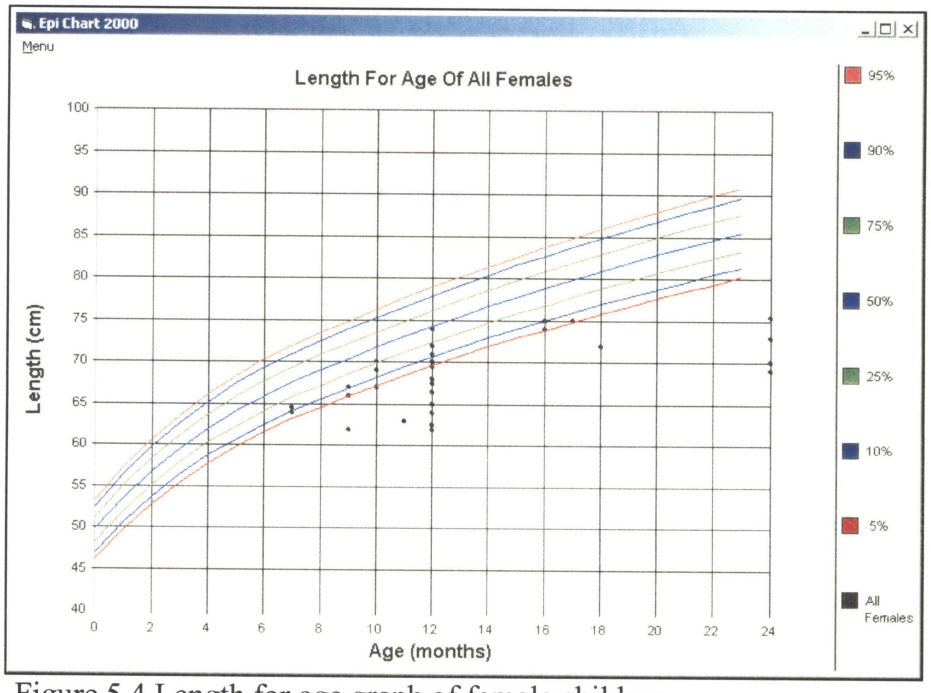

Figure 5.4 Length for age graph of female children

Table 5.5 Maternal satisfaction with the health and development of their children (N=71)

Mother's response	N	%
Do your children appear physically healthy?		
Yes	42	59.2
No	29	40.8
Do your children get sick more often than other children?		
Yes	35	49.3
No	36	50.7
Are you satisfied with the development of your children?		
Yes	40	56.3
No	30	42.3
No response	1	1.4

CHAPTER VI

LEGUME-FORTIFIED TRANSITIONAL FOOD DEVELOPMENT IN SIDAMA, SOUTHERN ETHIOPIA

Abstract

In most developing countries transitional foods are based on staple cereal or root crops. Imported or commercially developed foods are not easily accessible to low-income rural households due to high cost and poor availability. To improve the quality of children's diets in Southern Ethiopia, two transitional foods were formulated based on corn and an endogenous root crop (Enset ventricosum) product called kocho. Kidney bean and pumpkin were used to improve the protein and vitamin A value respectively. Corn:kidney bean:pumpkin (CBP) and kocho:kidney bean:pumpkin (KBP) had protein of 14.07g/100g and KBP:13.81g/100g respectively on a dry weight basis. Adding kidney bean to both mixtures improved amino acid pattern, but serving the foods as porridge created a low energy density product. On a wet-weight basis three large servings per day would be required to supplement breast milk. The presence of pumpkin in CBP and KBP increased the Vitamin A value of both mixes. Sensory evaluation of CBP by 30 mother and child pairs and KBP by 28 pairs indicated acceptance of the transitional foods. Thus use of kidney beans and pumpkin is a potential way to increase the nutritive value of transitional foods prepared from the two crops.

Introduction

The weaning period is considered the most critical period in an infant's life and a period of major public health concern (Egounlety, 2002). As infants transfer from nutritious and uncontaminated breast milk to the regular family diet they become vulnerable to serious deficiency diseases. The prevalence of malnutrition and mortality among children under five years old in developing countries such as Ethiopia is a major public health concern. As in most developing countries, infant foods in many parts of Ethiopia are cereal or root crop-based because these are common staples of the family's diet (Bekele and Berhane, 1998; Wolde-Gebriel, 2000). In developing countries foods are rarely modified at a household level to increase the nutrient density to meet nutritional needs of infants (UNICEF, 1993). The major deficiency diseases in Ethiopia include protein energy malnutrition (PEM), vitamin A deficiency, anemia, and goiter (Abuye et al., 1999; CSA, 2001; Haidar et al., 1996; Haidar & Tibeb, 1998; Lulseged and Fitwi, 1999; Wolde-Gebriel and Demeke, 1993; Wolde-Gebriel et al., 1991).

Traditional infant foods made of cereals or tubers are low in protein, vitamin A, zinc and iron; these nutrients are of special importance due to their impact on physical and cognitive development of children (Neumann and Harris, 1999). Furthermore the bulkiness of traditional weaning foods (Michaelsen and Friis, 1998) and high concentrations of fiber and inhibitors (Urga and Narasimha, 1998) are major factors reducing their nutritional benefits.

Development of transitional food is governed by the following guidelines: 1) high nutritional value to supplement breastfeeding, 2) acceptability, 3) low price, and 4) use of

local food items (Karyadi et al., 1990). Ideally, transitional foods need to contain animal food sources such as egg, milk, chicken, or fish with high biological value to foster growth and development (Neumann and Harris, 1999). However, these foods are not available to low-income households in most developing countries such as Ethiopia. For instance, in times of food shortage, livestock are sold as a survival strategy, making milk and milk products unavailable for children (Young and Jaspars, 1995). A practical alternative used in various countries is the fortification of locally grown food crops with legumes along with the addition of vegetables or fruits to enhance vitamin concentration (Marero et al., 1998).

Enhancing the nutrient density of transitional foods using local food resources is necessary mainly in low-income households where animal origin food in the diet is not an option (Latham, 1997). For example, corn has more protein (8g/100g) than kocho (1.5g/100g) but kocho is relatively cheaper than corn, which may be critical for some households. Recommending commercial weaning foods is not a possibility due to limited income and inaccessibility. Wolde-Gebriel (2000), using a cross sectional study of 334 mother and child pairs in Tigray, Ethiopia, reported that no child received "Fafa," a commercially produced cereal-based nutritious transitional food produced in Ethiopia. Thus the nutrient density of common foods in the family needs to be improved as a way to improve the nutritional status of children who do not receive commercial weaning foods. This study was conducted to teach mothers about the value of nutritionally appropriate transitional foods as opposed to a single crop food, which could affect the health and development of children. The study also involved mothers to evaluate the

acceptability of the transitional foods using sensory evaluation (affective) methods conducted at a central location.

Materials and Methods

Selection of Food Samples

Initially, interviews of rural women in the study area identified corn and kocho as staple foods used for child feeding. Therefore, corn and kocho were supplemented separately with kidney bean and pumpkin to increase their protein and vitamin A values. The goal was to increase the nutrient content of the two transitional foods to complement breast milk for children after six months of life.

Food Processing and Chemical Analysis

Prior to chemical analyses, corn and kidney beans were pre-cleaned, lightly roasted, de-hulled, and milled in local flourmills separately (Fig. 6.1). Kocho was sun dried, crumbled and sieved to collect the powder after removing visible fibers. Pumpkin was peeled, grated and sun dried (Fig. 6.1). The Ministry of Agriculture, Ethiopia approved the export of the food samples to the USA.

Duplicate samples of the foods (corn, kidney beans, kocho, and pumpkin) were analyzed for crude protein, amino acid profile, fat, and carotene at the Agricultural Experimental Station Chemical Laboratories, University of Missouri, Columbia (Appendices H and I). These results (Tables 6.1 and 6.2) were used to formulate the transitional foods containing protein density, amino acid pattern and vitamin A needs of infants (Table 6.4).

Table 6.1 Crude protein, fat and carotene content of food ingredients (dry weight basis)

Food Item	Scientific Name	Crude Protein[1] (g/100g)	Crude Fat[2] (g/100g)	Carotene[3] (µg /100g)
Corn	*Zea mays*	8.82	3.37	139.45
Kidney beans	*Vicia faba*	28.30	1.20	<2.00
Kocho	*Enset ventricosum*	1.50	0.15	16.15
Pumpkin	*Cucurbita pepo*	9.64	3.22	15.20[4]

[1]Crude protein was estimated following combustion analysis (LECO) AOAC Official Method 990, 03; 1995. [2]Crude fat was estimated by ether extraction, AOAC official method 920 39(A), 1995. [3]Carotene was estimated following AOAC official method 970.64, 1995. [4]Carotene for pumpkin is expressed in mg.

Table 6.2 Essential amino acid (EAA) composition of food ingredients (dry weight basis)

[1]EAA	Kocho	Corn	Kidney bean	Pumpkin[2]
	(EAA g/100g sample)			
Histidine	0.03	0.28	0.88	0.20
Isoleucine	0.06	0.32	1.28	0.35
Leuicine	0.11	1.03	2.26	0.46
Lysine	0.08	0.25	1.89	0.41
Methionine	0.03	0.16	0.33	0.26
Phenylalanine	0.07	0.43	1.57	0.54
Threonine	0.04	0.27	1.10	0.22
Tryptophan	0.04	0.07	0.30	0.09
Valine	0.08	0.43	1.47	0.39
Sum of EAA	0.54	3.21	11.06	0.20

[1]EAA profile was estimated in accordance to AOAC Official Method 982: 30E(a,b,c,), CHP, 45. 3. 05.1995

[2] Corrected from 'as is" to dry weight basis

Selection and Training of Rural Food Processors

Three Ethiopian mothers from the rural study area were selected to process the transitional foods for sensory evaluation. Selection was based on their earlier training as birth attendants and on recommendations by the head nurse of the nutrition unit at Bushulo Health Center where this study was conducted. The nature of the study and their expected duties in food purchasing, processing, and preparation of the transitional food

were explained to them. Oral consent was obtained from each woman and they were paid for their services based on local rates.

Processing of Food Samples

Food samples were purchased from a local market and processed. Corn and kidney beans were separately soaked in potable water for about six hours (Fig. 6.2), drained and germinated at room temperature for 48 or 24 hours, respectively (Marero et al., 1998). The seeds were rinsed in cold water, partially sun dried and roasted until light brown. Kidney beans were de-hulled; corn was lightly pounded to remove the hull and then milled in local mills. Kocho was sun dried and the lumpy pieces were crumbled. The dried kocho was then passed through a traditional household sieve to reduce fibers. Pumpkin was peeled and chopped into approximately 2 cm pieces which were boiled later for preparing the transitional foods.

Formulation and Preparation of Transitional Food Mixtures

Two transitional food mixtures, corn-kidney beans-pumpkin (CBP) and kocho-kidney beans-pumpkin (KBP), were formulated. Kidney beans obtained locally were added to complement the low protein content of the commonly used staple crops, kocho and corn. Pumpkin was added to contribute to the vitamin A value. Oil increased the energy density of the food, however, only one teaspoon (~4g) was added in the mixture because of high cost for these mothers. Corn and kocho were also prepared without adding additional ingredients to them, and they were later used for sensory evaluation.

Table 6.3 Food items used to prepare the transitional foods

Food Item (s)	Corn (g)	Kocho (g)	Kidney beans (g)	Pumpkin (g)	Oil (g)
Corn: kidney beans: Pumpkin	40	-	30	250	4.0
Corn	100	-	-	-	-
Kocho: kidney beans: pumpkin	-	30	40	250	4.0
Kocho	100	-	-	-	-

Sensory Evaluation

Selection and Training of Interviewers

Five technical staff of the Rural Development and Family Sciences Department of the Awassa College of Agriculture, Ethiopia, along with five local translators were trained as enumerators to collect the sensory evaluation data. The sensory evaluation questionnaire (Appendix J) included different categories indicating maternal and child preference along with purchase intent of tested transitional foods. In order to facilitate the data collection procedure, the questionnaire was translated into the Amharic language, which was commonly understood by the data collection team. As most of the mothers did not read and write, sensory evaluation data were collected by interviewing mothers. Each mother's response was recorded on a separate questionnaire which served as a score sheet. Before conducting the study, approval was obtained from the Oklahoma State University (OSU) Institutional Review Board (IRB) for all procedures (Appendices A-C). A local advisor from the Awassa Agriculture College, Ethiopia, also arranged for needed approvals in the study area (Appendix D). Additional approval was secured from

the Bushulo Health Center (Appendix E), the Ministry of Agriculture and the Farmer's Association Office in the study area in Awassa, Ethiopia

Sensory Evaluation Panelists

Mothers of children identified as malnourished (low weight) from outstation vaccination programs served as panelists and reported the response of their child. These women were attending child feeding classes at the nutrition unit of the Bushulo Catholic Health Service in Sidama, Southern Ethiopia. Two groups of mothers were selected to evaluate the four transitional foods. Group one included mothers whose children were fed in the nutrition unit once a week. Group two participants were selected from the twins program run by the same health center; mothers in this group usually received a can of powdered milk and a transitional food mixture biweekly to feed their twins in their own houses.

After securing permission to participate in the study, 28 mother and child pairs from the nutrition program and 30 mother and child pairs from the twins program participated in the sensory evaluation. In addition to maternal interest, children selected had already been introduced to semisolid or solid food. In order to determine which twin to involve, mothers were asked to identify the child who ate better and whom they thought was healthier. Only this twin participated in the sensory evaluation. This was done in order to reduce bias, which could be contributed by feeding the twins at the same time, one after another, or by different caretakers.

Sensory Testing of Transitional Foods

Affective testing using the central location method (Stone and Sidel, 1993) was carried out at Bushulo Health Center over a two-week period in July 2002. Traditional corn and kocho porridges were used as controls. Due to the challenges of administering a two-product random design in a rural community health center used as a busy training facility, panelists came to the center on two different days to test the samples. Mothers in the twins program were given the corn-based transitional foods while those in the nutrition unit evaluated the kocho-based transitional foods. Mothers and children were fed the control diet on day two and the transitional foods with legumes and pumpkin on day one. Participants tested only two products (with and without legume and pumpkin). Prior to conducting the sensory evaluation, mothers were instructed to give their honest opinion after tasting the transitional food mixture and feeding it to their child. Each mother was given a pre-weighed portion (100 g) of the transitional porridge to feed to her child and was asked to return any leftover food to the interviewers. Mothers evaluated the foods for appearance, smell, taste, and consistency using 5 point Hedonic scales where 5 was like a lot, 4 like a little, 3 neither like nor dislike, 2 dislike a little, and 1 dislike a lot. Mothers also interpreted additional attributes of foods such as the child's preference, discomforts, weight of food consumed, suggested price, and purchase intent (Appendix J). For ethical reasons, the twin who did not participate in the study also was fed in a location outside of the sensory evaluation area. At the end of the study each mother was given bars of soap, feeding cups, plates, and a snack as a token of appreciation.

Data Analysis

Variations in nutrient density of the two transitional food formulations and the sensory evaluation data were analyzed using descriptive statistics with the SPSS software program (SPSS, 2001). Affective testing for acceptability of the sensory attributes of transitional foods (appearance, smell, taste, and consistency) used a five point hedonic scale from which mean and standard deviation values were calculated. A one-way analysis of variance (ANOVA) was conducted to identify significant differences in the sensory attributes (appearance, smell, taste, and consistency) between legume fortified and traditional transitional foods. The significant differences were compared by Scheffe Multiple Comparisons Test.

Results

Nutrient Density

This study aimed at improving the nutrient density of transitional foods made from corn and kocho, which are common food crops used for weaning children in rural areas of Southern Ethiopia. Table 6.4 shows the energy, protein and vitamin A densities of the transitional foods prepared from legume and pumpkin fortified corn (CBP) and kocho (KBP) mixtures. Energy densities of CBP and KBP porridges were lower than the traditional corn and kocho porridges foods because more liquid was required to obtain a consistency similar to the unsupplemented products; this extra water resulted a low energy density.

Total protein increased in the legume fortified corn and kocho mixtures (Figure 6.1). Corn:kidney bean:pumpkin (CBP) and kocho:kidney bean:pumpkin (KBP) had a protein concentration of 14.07g/100g and 13.81g/100g) respectively on a dry weight basis, while the traditional corn and kocho had only 8.82 and 1.46g/100 of dry weight respectively. The protein density (% of energy) for legume fortified corn was 14.7% while the unfortified corn was 8%. For legume fortified kocho, protein density was 14.9% while the unfortified kocho was only 1%.

Table 6.5 presents the essential amino acid content of the legume fortified compared with unfortified corn and kocho traditional foods. The addition of kidney beans particularly increased the contents of the essential amino acids such as tryptophan, lysine, and threonine in the legume fortified corn and, lysine, isoleucine, threonine, and the aromatic amino acids (phenylalanine and tyrosine) in the fortified kocho. Among these amino acids, lysine in traditional corn (with a score of 0.48) and threonine in traditional kocho (0.81) had the lowest amino acid scores (Table 6.6).

Based on the assumption that carotenes in CBP and KPB contain 50% all-trans-B-carotene and 50% other dietary provitamin A carotenoids (IOM, 2001), the transitional foods would provide54 μg RAE/100 Kcal as fed. If vitamin A concentration is expressed in RE units, CBP provided 108 μg RE and KBP 109 μg RE.

Table 6.4 Nutrient densities of the transitional foods[1]

Nutrient density	Legume fortified corn	Traditional corn	Legume fortified kocho	Traditional kocho
Energy density (Kcal/g wet weight)	0.49	0.67	0.51	0.54
Protein density (% of energy)	14.1	8.0	14.9	1.0
Vitamin A density[2] (µg RAE/100 Kcal) wet weight	53.5	2.1	54.4	0.3

[1]Calculated values are based on chemical analysis for protein and vitamin A values and food table values for energy.
[2]Converted from total carotenes (assumed to be 50% all-trans-B carotene where 1 RE=12 µg RAE and 50% other carotenoids 1 RE=24 µg RAE)

Table 6.5 Essential amino acid concentration of the transitional foods (g/100g protein)

Essential amino acids	Legume fortified corn	Traditional corn	Legume fortified kocho	Traditional kocho
Histidine	2.95	3.12	2.91	2.06
Isoleucine	4.17	3.63	4.38	4.12
Leucine	8.44	11.68	7.49	7.56
Lysine	5.34	2.78	6.27	5.50
Methionine + cysteine	2.71	4.14	2.29	3.44
Phenylalanine + tyrosine	7.84	7.71	7.96	6.87
Threonine	3.35	3.01	3.53	2.75
Tryptophan	0.16	0.74	1.87	2.75
Valine	4.94	4.88	5.02	5.50

Table 6.6 Essential amino acid scores of the transitional foods

Essential amino acids	Legume fortified corn	Traditional corn	Legume Fortified kocho	Traditional kocho	FAO/WHO preschool standard[1]
Histidine	1.55	1.64	1.53	1.09	1.9
Isoleucine	1.49	1.30	1.56	1.47	2.8
Leucine	1.28	1.77	1.14	1.15	6.6
Lysine	0.92	0.48	1.08	0.95	5.8
Methionine+cysteine	1.08	1.66	0.90	1.37	2.5
Phenylalanine + tyrosine	1.24	1.22	1.26	1.09	6.3
Threonine	0.99	0.88	1.04	0.81	3.4
Tryptophan	0.87	0.67	1.70	2.50	1.1
Valine	1.98	1.95	2.01	2.20	2.5

[1]Food and Agriculture Organization of the United Nations, FAO (1991). Amino Acid Scoring Pattern. In Protein Quality Evaluation. Rome, Italy *51*, 21-25.

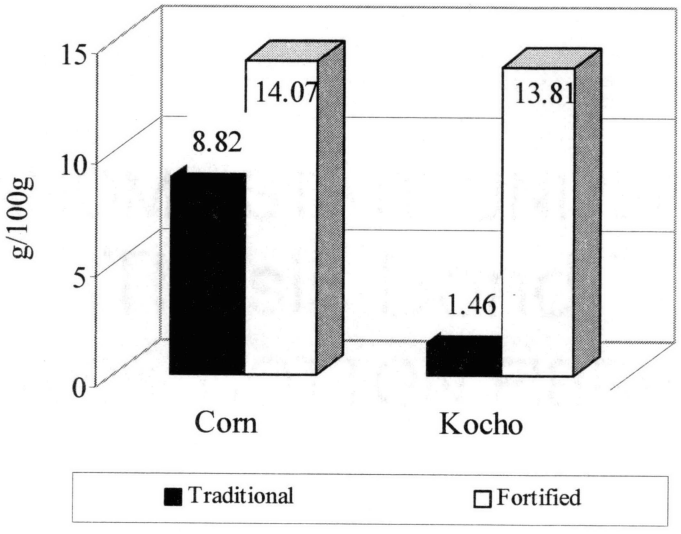

Figure 6.1 Protein content (g/100g) of legume-fortified transitional foods

Sensory Evaluation

The sensory evaluation panels were mothers and their children (13 ± 8 months of age). All of the children had been introduced to semisolid foods in their homes and were fed once a week at the nutrition unit of the Bushulo Health Center.

Mothers evaluated the sensory attributes of corn or kocho semi solid transitional foods with kidney bean and pumpkin added. All of the sensory attributes were favorably rated on the five point hedonic scales (Table 6.7). Mean scores and standard deviations ranged from 4.7 ± 0.9 to 4.9 ± 0.2 indicating that the attributes were liked very much. There were no significance differences ($p > 0.05$) between the sensory attributes of the corn and kocho-based transitional foods.

Table 6.7 Maternal ratings of the sensory qualities of the test foods

Sensory attribute	Mean Hedonic Score[1]			
	Legume-fortified corn (n=30)	Traditional corn (n=30)	Legume fortified kocho (n=28)	Traditional kocho (n=28)
Appearance	4.7 ± 0.8	4.9 ± 0.4	4.7 ± 0.8	4.7 ± 0.9
Smell	4.8 ± 0.8	4.9 ± 0.2	4.7 ± 0.7	4.8 ± 0.5
Taste	4.7 ± 0.8	4.9 ± 0.4	4.7 ± 0.7	4.8 ± 0.6
Consistency	4.7 ± 0.9	4.9 ± 0.3	4.9 ± 0.3	4.9 ± 0.4

[1]On a 5 point scale "5" was like a lot, "4" like a little, "3" neither like nor dislike, "2" dislike a little, and "1" dislike a lot. Values are presented as mean ± standard deviation.

Table 6.8 shows maternal interpretation of their child's preference for the transitional foods. According to mothers' interpretation of the child's preference based on

their prior feeding experience, no significant differences (p> 0.05) were observed between the traditional and fortified transitional foods. There also were no significant differences (p> 0.05) in weight of leftover food (Table 6.9). Generally all the products were well liked and there were no products that the child or mother preferred over others.

Mothers were asked about their intention to feed the corn or kocho-based transitional foods if price were not a consideration. More than 95% of the mothers who tasted the legume-fortified corn and more than 85% of the mothers tasting legume-fortified kocho expressed an intention to feed the fortified foods. No statistically significant differences (p> 0.05) were observed in mother's intention to feed the fortified or traditional corn and kocho-based transitional foods (Table 6.10).

Discussion

After six months children need to consume transitional foods of semisolid consistency with adequate energy and nutrient densities to supplement breast milk (WHO, 1998,). The child's capacity to obtain daily energy needs depends on the energy density of transitional foods, number of meals and the child's stomach capacity (Mbithi-Mwikya et al., 2002). Increasing the energy density of cereal or root crop-based transitional foods becomes a major challenge due to the gelatinization of the starch during boiling, which requires adding a large amount of water to have suitable consistency (Egounlety, 2002). This creates an undesirable nutrient dilution effect unless

other nutrient dense ingredients are added to the recipe. For example, the weight of kocho in this study increased more than seven fold after cooking into soft porridge.

Alternative ways to increase energy density without increasing viscosity have been suggested through addition of oil, adding a non-gelatinous carbohydrate such as sugar or using food processing techniques such as germination and fermentation (Mugula and Lyimo, 1999; Treche and Mbome, 1999). However addition of too much oil or sugar is not recommended because that would focuse on energy increase alone without considering protein and micronutrient density of the final mixed transitional food (WHO, 1998). In this study the energy density of porridge made from unfortified corn (0.67 Kcal/g) was higher than the fortified corn (0.49 Kcal/g), and may be due to the displacement of the higher fat content in corn (3.4 g/100 g) with the lower fat content in kidney beans (1.2 g/100 g) contributed to this decrease. The energy density in fortified kocho (0.51 Kcal/g) was slightly lower than the unfortified kocho (0.54 Kcal/g). The gelatinization of the starch in kocho during cooking demanded the addition of more water which reduce the energy density as indicated by Egounlety (2002) who discussed the challenges of using starchy crops in children's diets. Furthermore, the increased fiber contributed by kidney bean and pumpkin required addition of more water during cooking to make a porridge of suitable consistency which may be another reason for the reduced energy density of the legume and pumpkin fortified foods.

Involving mothers in nutrition education activities is recommended for improved nutritional status of young children. Kanashiro and colleagues (1991), using a community-based approach to develop transitional crop-based foods, reported energy

densities ranging from 0.39-2.33 kcal/g. Our products had energy densities that were slightly higher than the least energy dense products prepared by mothers in Peru as reported by Kanashiro et al. (1991). In order to raise the energy density to 2.33 Kcal/g, adding sugar, oil, or other ingredients would have been necessary, but this was not practical considering the resource limitations of these mothers. Protein density is also reduced by the addition of more oil (WHO, 1998). In the present study, the energy density from fortified corn (0.48 Kcal/g) was higher than the desired minimum energy density (0.44 Kcal/g) for 6-8 months old breast fed infants in four meals a day (WHO, 1998). On a wet-weight basis three large servings per day would be required to supplement breast milk.

The protein content of the transitional foods made from corn and kocho was improved to about 15% of the energy due to the use of kidney beans (Figure 6.1). The protein content of CBP was improved one and half times more than the traditional corn food, and KBP increased protein by nine fold over traditional kocho. The protein density in CBP and KBP were higher than the 5.5-10.7% protein densities reported by Kanashiro et al. (1991).

Table 6.5 shows the increased amino acid content (g/100g protein) in the transitional foods. Lysine, which was the most deficient in the traditional corn transitional food, was increased more than two times, and the second limiting amino acid in corn, tryptophan, increased more than two and a half times. In the traditional kocho diet, lysine and threonine increased slightly. As presented in table 6.6, the distribution of the amino acid pattern in the kocho-based diet improved to chemical scores of >1 except for the

sulfur containing amino acids (methionine and cysteine) with a score of 0.9. These scores for sulfur containing amino acids were higher than scores reported by Jirapa (2001) for roasted kidney beans (0.74).

Although kocho had low protein content (1.5g/100g kocho), it has a good distribution of the essential amino acids. If supplemented with higher protein density foods such as legumes, kocho could be improved as infant food for communities who depend on kocho as the major household diet. The use of even small amounts of animal source foods would be more beneficial. Having a good mixture of amino acids (along with adequate intake of energy nutrients) is critical for better utilization by children whose essential amino acid requirement is more than adults (Latham, 1997).

In most cases transitional food development focuses on improvement in protein density (Mibthi-Mwikya et al., 2002). However, in this study the use of pumpkin improved the vitamin A density in CBP and KBP. Compared to the unfortified corn and kocho diet, the improvement in the vitamin A value was more than 25 fold in CBP and over two hundred times increase in KBP.

Based on the most recent recommendation by the Food and Nutrition Board (IOM, 2001), Estimated Average Requirement (EAR) for children aged 1-3 years is set at 300 μg RAE daily. However, the amount estimated to prevent night blindness is 112 μg RAE daily. The transitional foods would provide about half the amount needed to prevent blindness and about 20% of the EAR in 100Kcal of product.

Legumes are valuable in the diet because they are relatively low cost and are good sources of protein, B vitamins and carbohydrates (Latham, 1997). According to WHO

(1998), the amount of protein and other nutrients that should be provided by transitional foods is determined by the amount of breast milk consumed. A 12-23 month old child with average breast milk intake needs to obtain at least 5 g of protein from transitional foods (WHO, 1998). About 35 g (dry weight) of the transitional food mixture would provide 5g of protein required to meet the protein need of infants with an average breast milk intake.

The nutritional impact of fortified transitional foods has been tested in feeding trials. Obatolu (2003) reported that infants from low income families in Nigeria who were weaned to a maize and cowpea transitional food had significantly higher weight gain at 18 months compared to the control group without the transitional food. Lartey and colleagues (1999) randomly assigned 6-12 month old Ghanaian infants to weanimix, weanimix plus vitamins and minerals, weanimix plus fish powder, koko (fermented maize porridge) plus fish powder, or a control group with no intervention. They reported no significant difference in weight or length or serum vitamin/mineral concentrations at baseline. However, after 3 months on the diets, *z*-scores for the intervention groups were reported to be higher than the control group.

To conduct sensory evaluation with young children, best practice is for caretakers to interpret the child's food acceptance behavior in the home situation prior to exposure of the child to the test food (Gerrish and Mennella, 2001). In testing the acceptance of novel foods (pureed carrots and pureed chicken) by formula-fed infants, Gerrish and Mennella (2001) assigned 48 non-smoking mothers with their infants to three different test foods (carrots, potatoes, and a variety of vegetables). The study design involved a

nine-day home exposure period after which each group was fed only a single food. After the nine-day home exposure period, each group of mothers along with their infants came to a central location on three different days for the food acceptance test. In analyzing the data, mother's perception of their infants liking of the food was considered. Results indicated that infants ate more carrots and vegetables (not potatoes) after the home exposure period. Home experience also was related to acceptance of pureed chicken.

Guinard (2002) recommended using caretakers in sensory evaluation not only due to their ability to interpret the child's food preference, but also because of the importance of their acceptance of the product for later purchasing decisions. This is considered important in the children's food market in that it provides information on whether adults like the foods enough to purchase them.

Parker and colleagues (1998) used focus group discussions to evaluate maternal preferences for consistency of transitional foods in Guatemala. Results indicated that mothers preferred thinner consistency foods for children less than one year old and thicker consistency foods for children older than a year. When children have coughs or fever, most indicated the use of thin consistency foods, and thick consistency was used for diarrheal diseases.

Most of the theoretical base for conducting sensory evaluation relates to normal circumstances where food resources are adequate. Unlike the recommended practices of serving varieties of foods repeatedly for healthy eating habits, children who lack adequate food could eagerly eat tasted foods due to hunger. This may not represent an accurate assessment of the acceptability of tested products using standard sensory evaluation

procedures. At the same time, low-income caregivers in such situations may be inclined to give higher scores to be grateful, which could affect test results. This suggests the need for applicable methods when conducting sensory evaluation in low-income households with non-literate subjects. A possible suggestion could be to provide foods to be tested in the family setting for a period of time and ask caregivers to give their evaluation individually or in a small focus group.

Conclusions and Recommendations

Children in most developing countries are introduced directly to the regular household diet made of cereal or starchy root crops. Studies have shown that child malnutrition starts with the introduction of such foods. The main purpose of this study was to address the need for adequate transitional foods by using approaches that are adaptable to the local environment of the study area. The use of the transitional food would improve the protein and vitamin A status of children. Food items used in the transitional foods also are known to mothers in the community.

The relative deficiency of nutrients in corn and kocho were enhanced by using kidney bean and pumpkin. The addition of these foods to the traditional corn and kocho based transitional foods improved the protein content, amino acid pattern and vitamin A value of the transitional foods.

The addition of kidney beans and pumpkin to enhance the protein and vitamin A contents of transitional foods is an example of nutritional enhancement by the use of locally available foods that are affordable to households in the community. However,

additional food sources such as kale, yellow sweet potatoes, avocado, and papaya that also grow in the area should be considered as alternative vitamin A sources to improve the nutrient density. The use of avocado which has a high fat content would be a potential way to increase the energy densities of both CBP and KBP but may be too costly for some families.

Provision of inadequate transitional food is a major cause for the high incidence of child malnutrition, morbidity and mortality in many developing countries (Egounlety, 2002). This study used a community-focused approach, which encouraged community members to participate in activities concerning them (Green et al., 1997). The participation of the community, mainly mothers of young children, in transitional food formulation and acceptability testing encourages caretakers to gain nutrition knowledge and positive attitudes towards dietary improvement (Muroki, et al., 1997). In this study participation in food selection, processing, preparation and sensory evaluation tasks involved mothers in transitional food processing, which could increase their awareness about the need for adequate transitional foods for their children. All of the products tested in this study were accepted by mothers as reflected by high sensory evaluation scores (Table 6.6).

Transitional foods should be part of an effort that promotes exclusive breastfeeding in the first 4-6 months of age and hygienic practices during processing, preparation and storage of transitional foods (WHO, 2001). Sanitary practices in preparing transitional foods involve the quality of water to be used in preparation and sanitary conditions in the surroundings, including personal hygienic practices during food

preparation and serving. Such sanitary measures are very important for all children, but especially for those at risk of malnutrition (Hofvander and Underwood, 1987). Most of the sanitary measures need extra money, which may not be available to most low-income mothers in developing countries. However, once mothers understand the risk of contamination for their children's health, they would make extra efforts regardless of their economic limitation.

On a community level, the promotion of transitional foods needs culturally relevant education and communication, applicable to non-literate mothers. Possible strategies include encouraging increased breastfeeding frequency for increased energy, increased portion sizes and frequency of feeding, or provision of more energy dense foods if available. In addition, alternative strategies to enhance micronutrient adequacy of crop-based transitional foods need to be devised (LINKAGES Project, 1997)

Table 6.8 Maternal ratings of child's preference for the transitional foods

Child's food preference	Maternal Response	Legume fortified corn		Traditional corn		Legume fcortified kocho		Traditional kocho	
		N	%	N	%	N	%	N	%
Did the child like the food?	Liked or liked very much	29	96.7	30	100	27	96.4	25	92.6
	Disliked or disliked very much	1	3.3	0	0	1	3.6	2	7.4
Child ate all the food served	Ate all	25	83.3	25	83.3	24	85.7	25	92.6
	Did not eat all	5	16.7	5	16.7	4	14.3	2	7.4

Table 6.9 Weight[1] of transitional foods not consumed by children per 100 g serving

Weight of food	Legume fortified Corn	Traditional Corn	Legume fortified Kocho	Traditional Kocho
Weight of food remaining (g)	7.0 ± 20.0	6.1 ± 16.1	4.2 ± 7.4	3.5 ± 14.1

[1]Values are expressed as mean ± SD

Table 6.10 Mother's intent of feeding product to children if price were not a consideration

Response	Legume fortified corn		Traditional corn		Legume fortified kocho		Traditional kocho	
	N	%	N	%	N	%	N	%
At every opportunity	15	50.0	14	46.7	10	35.7	8	28.6
Will feed often	14	46.7	15	50.0	14	50.0	19	67.9
Once in a while	1	3.3	1	3.3	4	14.3	1	3.6

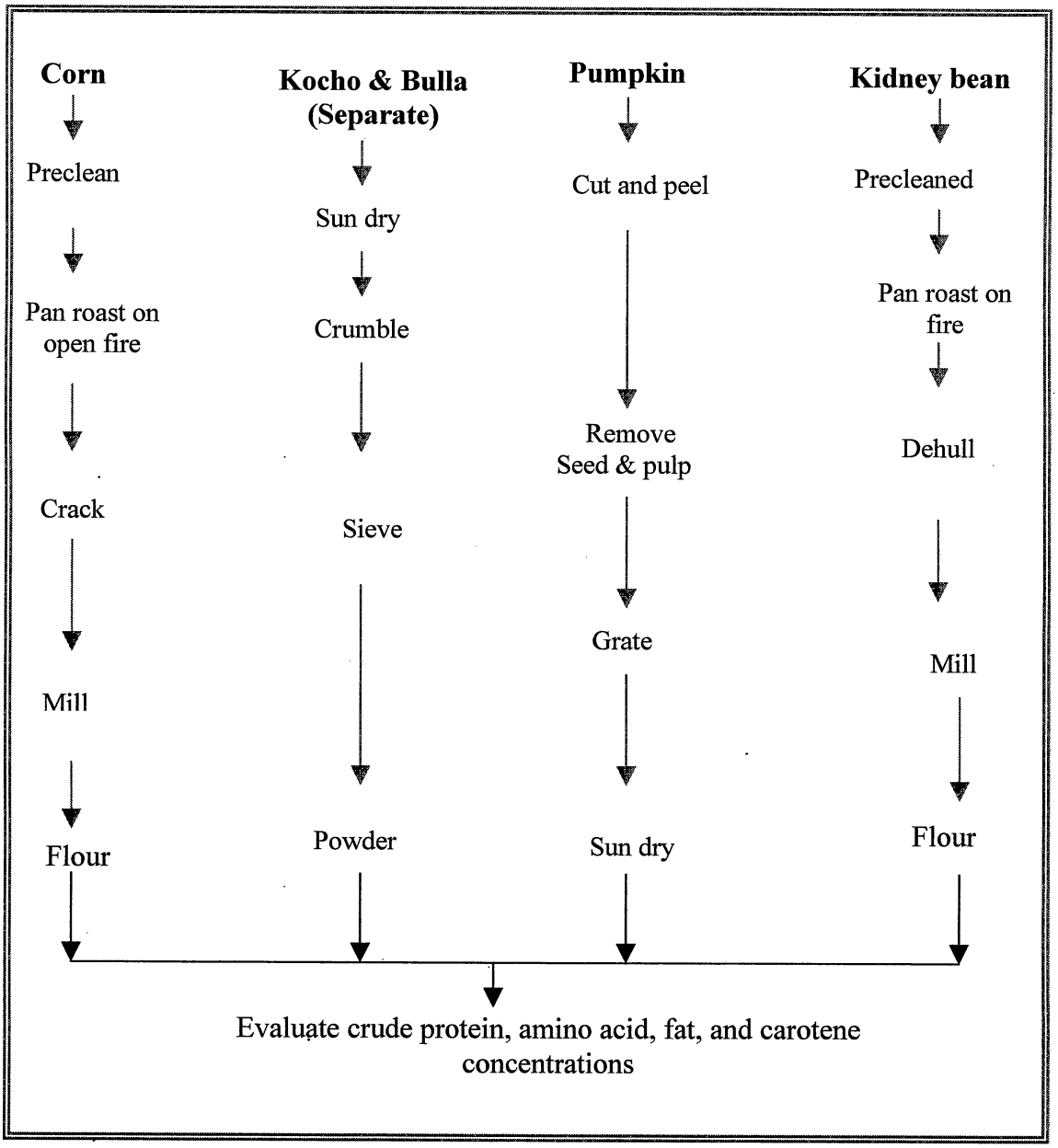

Figure 6.2 Flow diagram of food processing operations prior to chemical analysis

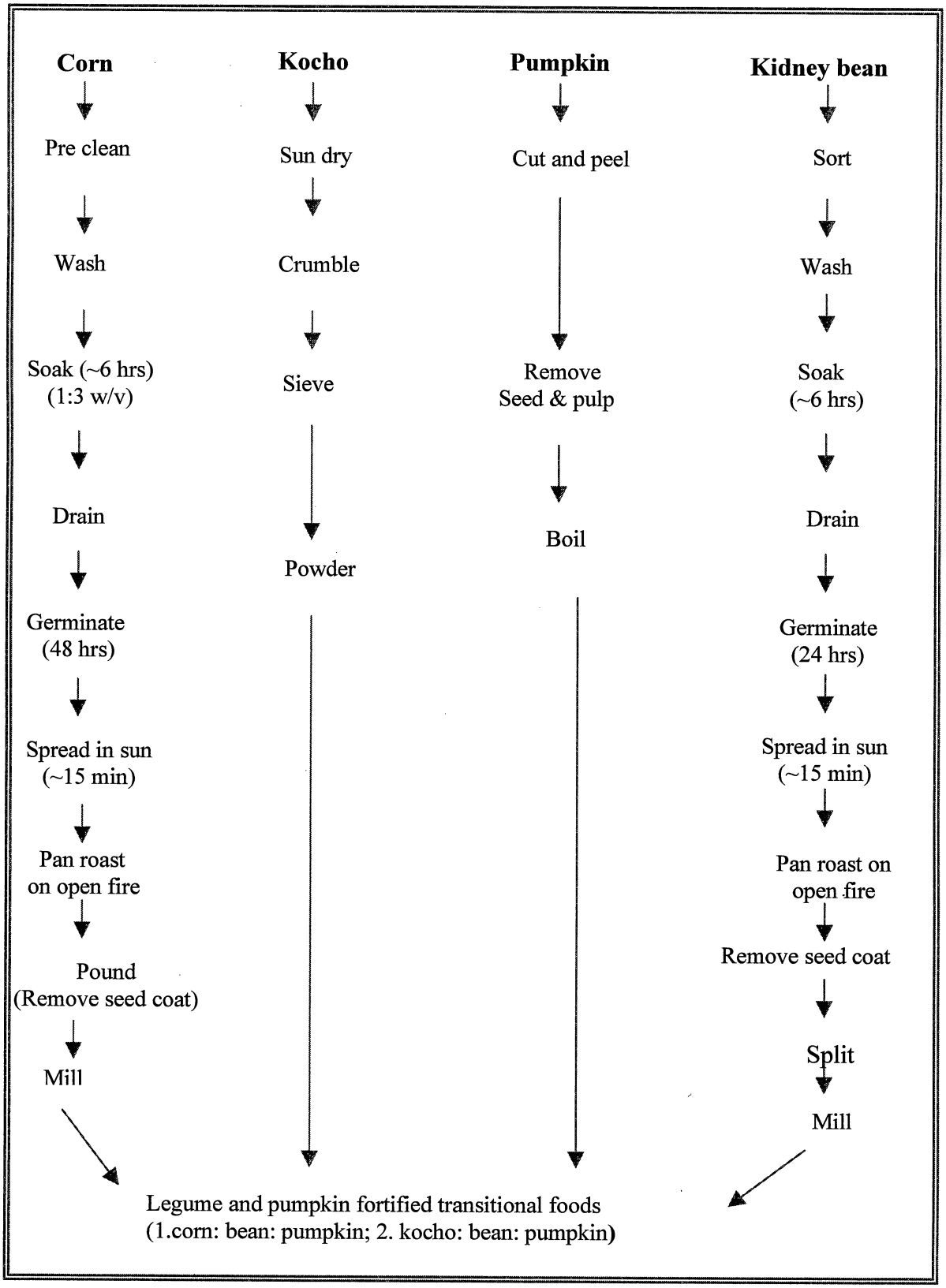

Figure 6.3 Flow diagram for preparation of transitional foods

CHAPTER VII

SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND POLICY IMPLICATIONS

Summary

This summary presents the findings of a nutritional assessment study conducted with low-income mothers and children under five years of age in southern Ethiopia. The study has five parts organized into three major sections. The first section identified food production, consumption, child feeding practices and child mortality among study participants. The second part assessed the nutritional status of these children and their mothers using anthropometric measures. The third part tested acceptability of legume-fortified transitional foods designed to improve the nutrient intake of children. A community-based approach was used by involving mothers in the study community in development and testing of the transitional foods and interviewing selected professionals working in the study area (Appendix L).

In examining food production and consumption, most households produced corn and a root crop for home consumption. Mothers felt that their inadequate food production and consumption were affected by large family size and small land size. They felt that family income was less than adequate to meet the food needs of their family. Although most family members could face inadequate diet because of the limited food production, children are at greater risk because of their increased need for adequate nutrition to cover their physiological needs. The extended breastfeeding, lack of adequate transitional food,

and lack of animal source foods observed in this sample most likely contribute to the high degree of malnutrition in these children. The high incidence of child mortality (40%) in the first year of life may be a consequence of severe malnutrition. Reported causes of child death such as respiratory problems, vomiting, diarrhea, *Fincho*, and measles may be reflections of the poor nutritional status of children.

With respect to the second part of this study, the low anthropometric scores of children confirmed the poor nutritional status reported in the first part of this study. More than 40% of children were underweight or stunted, 4% were wasted, and more than 40% of the mothers were underweight. The high child mortality in the first year of life and reported causes of death indicate that efforts to improve the nutritional status of children need to be maximized.

The third section of this study aimed to improve the nutrient density of corn by combining it with kidney bean and pumpkin. The use of locally grown kidney beans and pumpkin improved the protein content on a dry weight basis, the limiting amino acid profile, and the vitamin A content of corn and kocho-based transitional foods. These transitional foods will improve the nutritional status of children but three large servings daily will be needed and breastfeeding will need to be continued. However, if more nutrient dense foods, especially animal products, could be incorporated in the products the nutritional benefits of the developed transitional foods would be maximized.

Professionals in the ministries of Agriculture and Health indicated the need for integrated child-focused intervention programs to better meet the nutritional and health needs of children in Ethiopia (Appendix L). Ministry of Agriculture professionals suggested the need for programs that promote increased household food security,

improved food preparation, and income generation for women. Ministry of Health professionals suggested the need for more health education, vaccination and family planning services for mothers. In implementing suggested programs, professionals in both ministries emphasized the need for community-based approaches and increased cooperation between organizations. Professionals from the Ministry of Agriculture noted that a productive society cannot be guaranteed without healthy children.

The involvement of mothers in the processing and acceptability testing is a direct interactive method to involve mothers in nutrition activities that will improve the nutritional status of their children. The sensory evaluation results indicated the high acceptance of the transitional foods by mothers and their children. For this evaluation and for the regular child feeding program we observed at Bushulo Health Center, mothers and their children from surrounding villages traveled long distances on foot to attend the program. This supports the idea that mothers will participate in nutrition activities that affect the health of their children.

Limitations

Subjects for this study were purposefully selected low-income mothers attending the child feeding service at Bushulo Health Center. The responses they provided to the interview questions could be influenced by prior knowledge gained from the program. Furthermore the children were likely to be more malnourished than the population in the area because only malnourished children were enrolled in the program. Although local interviewers were trained, it is possible that they misunderstood or misinterpreted either the questions or the responses of subjects. The room where sensory testing was conducted did not conform to sensory evaluation guidelines (e.g., each mother –child pair was not

fed in a separate room). Because of cultural norms, mothers may have given a higher score to tested transitional foods to be grateful.

Conclusion and Recommendations for Practice

The effect of malnutrition in the early years of life and its impact on later development has been known. The main observation from this study is that children in the feeding program were stunted and experienced serious undernutrition. The most vulnerable age group is between 1-2 years as indicated by over 40% mortality rates in the first year of life. Based on the data from this study, there is a high possibility that inadequate weaning foods and occurrence of infectious diseases are determining factors of undernutrition in this age group.

For children in this study, the major source of protein was from plant foods. Hence, unless cereals and legumes are balanced in family meals, it may be possible for children to lack essential amino acids required for protein synthesis and growth. Furthermore, in a low energy diet, the limited protein consumed could be diverted from protein synthesis to provide energy. Another possible limitation of a predominantely crop-based diet is the presence of certain inhibitors such as fiber and phytates, which could reduce absorption of nutrients such as zinc (WHO, 2002). Dietary zinc requirements for dietary intakes are adjusted upwards for populations in which animal source foods (best sources of zinc) are minimal, and plant sources of zinc are high in phytates (WHO, 2002).

The findings in this study suggest the need for increased support to improve the nutritional status of children through integrated programs. The resource limitations of families could be addressed through selected livelihood and income support micro-credit

projects such as poultry and dairy goat production as suggested by majority of mothers in this study. As most of these mothers have experience in agriculture, vegetable gardening including soya bean production would be a valuable way to increase nutrient content if they receive seeds and occasional advice from development agents.

Recommendation For Future Research

1. Further studies need to consider ways to increase energy and micronutrient densities of the transitional foods. In addition, the impact of household food processing technologies such as soaking, germination and fermentation on the nutritional value and microbial contamination of cereal and root crop based transitional foods need to be considered. Studies on preparation and testing of transitional foods in the home environment are needed.

2. Intervention studies on the effectiveness of the legume-fortified transitional foods could be evaluated by involving three groups (about 30-40 in each group) of mothers having 6-12 month old children matched with required characteristics (age, education level, income) at three different sites.

   The legume-fortified corn and kocho-based transitional foods along with a specific nutrition education message (intervention 1 and 2) could be used as interventions. The nutrition education for the intervention would address appropriate foods for child feeding, frequency of feeding and general education. The impact of the interventions may be evaluated by assessing anthropometric

indicators of children and maternal nutritional practices at baseline and after six months.

3. Sensory evaluation of transitional foods may be assessed by involving mothers of average income and healthy children. Assuming cost is not a consideration, an adequate amount of the transitional food mixture could be given to mothers to prepare as demonstrated and feed it to children for about a week in their homes. After about a week, sensory evaluation using Affective Testing Methods could be conducted for selected sensory attributes.

4. Nutrition and health education should focus on teaching mothers about the importance of adequate child feeding to avoid the risk of malnutrition. Mothers in this study identified "Fincho" as a major cause of child death; although we did not assess mothers' perception, several mothers did not seem to relate "Fincho" with nutritional deficiency.

Policy Implications

The impact of malnutrition in affecting human performance, health and survival, including physical growth, morbidity, mortality, cognitive development, reproduction, and physical work capacity is well documented (Pelletier and Frongillo, 2002). Hence the important role of government policies in identifying strategies that could reduce the incidence of malnutrition is important. Policies affect nutrition in a direct or indirect way. Policies such as the iodization of salt, or immunization programs affect nutrition directly

while others such as income and price policies affect nutrition indirectly (UNICEF, 1986).

The data gathered from the three parts of the study and opinions of professionals at the Ministry of Agriculture and the health professionals at Bushulo health center support policies that would address the following areas.

1. Encourage adequate household food security through improved crop and animal production along with preservation technologies.
2. Target vaccination and family planning coverage for mothers and children who do not normally come to clinics.
3. Provide clean drinking water to control diarrheal diseases and reduce childhood morbidity and mortality.
4. Educate and train professionals for improved nutrition and health communication to mothers.
5. Support applied research on food resources, to develop ideal foods for promoting child health and development.
6. Use geographic data to target nutrition intervention programs to the society's most vulnerable groups, such as women and children (Morris et al., 2000).

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APPENDICES

Appendix A

Institutional Review Approval Form

Oklahoma State University
Institutional Review Board

Protocol Expires:

Date : Monday, April 24, 2000 IRB Application No: HE00167

Proposal Title: PARENT FOCUSED NUTRITION INTERVENTION FOR WEANING FOOD DEVEOPMENT IN RURAL HOUSEHOLDS OF ETHIOPIA

Principal Investigator(s) :

Yewelsew Abebe
425 HES
Stillwater, OK 74078

Gail Gates
425 HES
Stillwater, OK 74078

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s) : Approved

Signature : Carol Olson

Carol Olson, Director of University Research Compliance

Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

Appendix B

Modified Institutional Review Form
Oklahoma State University
Institutional Review Board

Protocol Expires: 5/15/02

Date: Wednesday, May 16, 2001 IRB Application No HE00167

Proposal Title: PARENT FOCUSED NUTRITION INTERVENTION FOR WEANING FOOD DEVELOPMENT IN RURAL HOUSEHOLDS OF ETHIOPIA

Principal Investigator(s):

Yewelsew Abebe
425 HES
Stillwater, OK 74078

Gail Gates
425 HES
Stillwater, OK 74078

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved – Continuation

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Dear PI :

Your IRB application referenced above has been approved for one calendar year. Please make note of the expiration date indicated above. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved projects are subject to monitoring by the IRB. If you have questions about the IRB procedures or need any assistance from the Board, please contact Sharon Bacher, the Executive Secretary to the IRB, in 203 Whitehurst (phone: 405-744-5700, sbacher@okstate.edu).

Sincerely,

Carol Olson

Carol Olson, Chair
Institutional Review Board

Appendix C

Institutional Review Continuation Form
Oklahoma State University
Institutional Review Board

Protocol Expires: 5/15/03

Date : Thursday, May 16, 2002 IRB Application No: HE00167

Proposal Title: -PARENT FOCUSED NUTRITION INTERVENTION FOR COMPLEMENTARY FOOD DEVELOPMENT IN RURAL HOUSEHOLDS OF ETHIOPIA

Principal Investigator(s) :

Yewelsew Abebe
425 HES
Stillwater, OK 74078

Gail Gates
425 HES
Stillwater, OK 74078

Reviewed and Processed as: Expedited **Continuation**

Approval Status Recommended by Reviewer(s) : Approved

Signature :

Carol Olson, Director of University Research Compliance

Thursday, May 16, 2002
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

Appendix D. Acceptance Letter of a Local Advisor

አዋሳ ግብርና ኮሌጅ

AWASSA COLLEGE OF AGRICULTURE

ቀን Date 8/4/2000

ቁጥር Ref. No. AD 140/82

Dr. Gail Gates
Fax No. 4057447113
U.S.A

Dear Dr Gates,

I am writing this letter to inform you of the fact that I have accepted Mrs. Yewelsew Abebe's request to be her local advisor.

I am Associate Professor of Dairy Technology at the Awassa College of Agriculture, Debub University.

The proposal of Mrs. Yewelsew is accepted by the College, and the Research & Extension of the college would give the necessary support in under taking her research at Awassa.

With best regards!

Fekadu Beyene (Dr)
Associate Professor
Awassa College of Agriculture

AWASSA COLLEGE OF AGRICULTURE
OFFICE OF THE ACADEMIC V/ DEAN

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Appendix E.

Request for Cooperation to Bushulo Health Center

አዋሳ ግብርና ኮሌጅ

AWASSA COLLEGE OF AGRICULTURE

ቀን Date June 7, 2001

ቁጥር Ref. No. REO/1065/93

Catholic Church Health Center
Bushulo, Awassa

Dear Sir/Madam,

Mrs. Yewelsew Abebe is a staff member of Awassa College of Agriculture and is presently studying for her Ph.D. Her research focuses on development of supplemental food products and she is planning to conduct filed studies with the supplements she has formulated from locally available food types.
I am writing this letter to request you to extend your usual cooperation to Mrs. Yewel and facilitate her research activities with families in your mandate area.

We believe the information to be generated through such collaboration can be beneficial to the people in the Sidma region and elsewhere.

Best regards,

Girma Abebe
Coordinator for
Research and Extension

ግብርና ኮሌጅ ምርምርና ማስፋፋት ቢሮ RESEARCH AND EXTENSION OFFICE AWASSA COLLEGE OF AGRICULTURE

Appendix F

Interview Questionnaire

Identification

1. Name of farmer's association_____
2. Zone_____Region_____District_____
3. Name of household's head_____
4. Male___ Female_____
5. Date of interview_____Started_____ Ended_____
6. Name of interviewer_____

Section I: List Regular Family Members

No	Name	Gender	Age	Height (Cm)	Weight (Kg)	Arm Circumference (Cm)	Education level[a]	Relationship
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

[a]Education level 1) Able to read and write, 2) Not able to read and write, 3) Completed elementary school (1-6 grade), 4) Completed junior secondary school (7-8grade) 5) High school (9+)

Section II: List the main foods of the household.

RQ 1:What are the food consumption patterns in the study area?

1. Please tell us the most consumed foods from each group (Interviewer: tick at the appropriate cell)
2. What is the purpose of production? Tick on the appropriate cell

Cereals	A	B	C	Legumes	A	B	C	Vegetables and Root crops	A	B	C	Fruits	A	B	C	Animal Products	A	B	C
Corn				Broad beans				Kocho				Avocado				Milk			
Teff				Peas				Bulla				Banana				Yogurt			
Wheat				Chick pea				Cassava				Oranges				Butter			
Barely				Lentil				Boyna				Guava				Cheese			
				Guava				Godere				P. apple				B.milk			
				Beans				Potatoes				Lemon				Beef			
				Soya beans				S. Potatoe								Egg			
								Cabbage								Chicken			
								G. Pepper								Lam			

A=Sell; B= Home consumption; C=Half sold half consumed.

Food Service

3. How is the food served and distributed? (Who is served when? Use 1st 2nd)
   A) Mother__ C) Children ___ E) Other___
   B) Father___ D) Guests ___
4. What meals are regularly served in a day?
   A) Breakfast_____ C) Dinner____
   B) Lunch_____ D) Snack____E) Other_____
5. What foods does the household not eat?

Food	Reason for not giving

Some people say that food availability is difficult these days. What factors do you think affect adequate food availability?

Factors	Elaborate
-Family size	
-Land size	
-High Food price	
-Other?	

RQ 2: What is the child feeding practice of the study area?

6. What are the first foods, and drinks the child is fed soon after delivery?
   A) Breast milk____ C) Boiled water E) Goat's milk_____
   B) Cow milk_____ D) Un-boiled water F) Other_____
7. Do you add water to the milk?
   A) Yes _____ B) No____
8. How long do you breast feed?
   A) 1-6 month____ C) 1-2 years E) 3-5 Years____
   B) 6-12 month___ D) 2-3 Years F) Other_____
9. When do you wean your baby?
   A) 1-6 month____ C) 1-2 years E) 3-5 Years____
   B) 6-12 month___ D) 2-3 Years F) Other_____
10. What is the process of weaning?
    A) Abrupt____ B) Gradual____ C) Other_____
11. At what age do you give additional food to your baby? _____months
12. What type of food is given after weaning? Underline major ingredients used

Food	Write Other Ingredients added (Eg. Milk, egg)
-Porridge (Wheat, Barely. Corn. Kocho, Teff)	
-Gruel (Wheat, Barely. Corn. Kocho, Teff)	
-Other	

14. How often do you give food to your child?
    A) 1-2 times____ C) 4-6 times_____
    B) 3-4 times____ D) Other_____

15. Who feeds the child?
    A) Mother_____ B) Father_____ Grandmother_____
    C) Sibling_____Age___ D) Other_____

16. What foods and drinks are considered good for the child? Why?

Name of Foods	Benefit of the Food
1	
2	
3	
4	

17. What are the foods and drinks a child should not eat?

Name of Foods	Reasons for Avoiding Food
1	
2	
3	
4	

18. What foods and drinks are considered medicinal for the child?

Name of Foods	Name of Disease Food is Good for
1	
2	
3	
4	

RQ 3: What is the nutritional status of children involved in the study area?

19 Do your children appear physically healthy?

Yes_____ No_____

Explanation (Yes/No)_____

20 Are you satisfied with the development of children children?

Yes_____ No_____

21 Do your children get sick more often than other children?

Yes_____ No_____

No of children died and age: Age_____Number_____

Major Cause_____

22 Where do you take your children when they get sick?

A) Clinic_____ B) Traditional healers_____

C) Treat them myself_____ D) Other_____

RQ4: What socioeconomic factors affect the nutritional status of children?

23 What is the main source of household income?

A) Agricultural products____ B) Livestock Products_____

C) Petty trading_____ what? _____D) Selling labor____

D) Other_____

24 How adequate is your income to cover your family needs?

A) More than enough_____ B) Enough_____ C) Barely enough___

D) Less than enough_____ any comment?_____ Months food is:

25 How many children do you have, and how old are they?

A). Number_____ B). Ages_____

What are the services influencing the nutritional status of your child?

A) School_____ Level_____ Gov/Private_____
B) Hospital/Clinic_____ Gov/Private_____
C) Church_____ D) Other_____
_____

27 ***Are there services you wish to use to for your children and can't because you can't afford? Indicate those services***

Not accessible services	Reasons (if you have to pay for such services what is your approximate expense per child/monthly?	Expected expense per child/month

RQ5: What are the common diseases affecting children's nutritional status?

28 What common diseases affect your children and what are their causes?

Name of Disease	A) Poverty	B) Lack of sanitation	C) Large family size	Evil eye	Other
A) Measles					
C) Malaria					
D) Parasitic					
E) Other					

What foods, drinks, herbs, do you use to treat these diseases?

Name of Disease	Type of treatment (medicines/herbs/foods given or withdrawn)
1	
2	
3	
4	

RQ6: What are the views of parents for weaning and supplemental food formulation Circle appropriate category?

	When I think about the health and growth of our children	Strongly Agree	Agree	Disagree	Strongly Disagree
30	Children in our community get adequate food and care				
31	The family's food is adequate for children				
32	Child feeding training is not needed for parents				
33	More number of children is an asset for the family				
34	Children in earlier days were better of health wise than children in recent days				
35	Boys need better foods than girls				
36	Having weaning and supplemental food is necessary for children				
37	Food shortage is the only cause affecting the health of children				

Strongly agree=4, Agree=3, Disagree=2, Strongly disagree=1

Thank you for your participation

Appendix G

Anthropometric Data Record Form

Mother				Child								
Name	Age	Wt (kg)	Ht (cm)	Name	Sex		Age (Mo)	Wt (kg)	Ht (cm)	Position		MAC (cm)
					M	F				R	S	

Appendix H

Chemical Analysis of Food Samples (Letter)

University of Missouri-Columbia
College of Agriculture, Food and Natural Resources

Experiment Station
Chemical Laboratories
Room 4
Agriculture Building
Columbia, MO 65211
PHONE (573) 882-2608
FAX (573) 884-4631

May 31, 2001

Dr. Gail Gates
Oklahoma State University
425 HES Building
Stillwater, OK 74078

Dear Dr. Gates:

Please find enclosed a completed report of analysis for the samples we received May 07, 2001.

We have assigned lab numbers 4456-4461 to your samples. Reference standards were performed.

A University of Missouri invoice will be sent to you by the Accounting Department for payment of these services.

The original results will be on file in our office and available to you upon request. We are glad that we have been able to work with you on this project and look forward to being of service to you again.

Please let us know if you have further questions.

Agriculture Experiment Station
Experiment Station Chemical Laboratories
University of Missouri-Columbia

Sincerely,

Dr. James K. Waters
Research Chemist

Dr. Thomas P. Mawhinney
Director

Enclosure

Appendix I

Chemical Analysis of Food Samples

University of Missouri-Columbia
College of Agriculture, Food and Natural Resources

Experiment Station
Chemical Laboratories
Room 4
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PHONE (573) 882-2608
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Please let us know if you have further questions.

Agriculture Experiment Station
Experiment Station Chemical Laboratories
University of Missouri-Columbia

Sincerely,

Dr. James K. Waters
Research Chemist

Dr. Thomas P. Mawhinney
Director

Enclosure

ESCL College of Agriculture - UMC
Experiment Station Chemical Laboratories

University of Missouri-Columbia Room 4 Agricultural Building Columbia, Missouri 65211

Sender: Dr. Gail Gates
Company: Nutritional Sciences Department, Oklahoma State University, 425 HES Building, Stillwater, OK 74078
Phone/FAX: 405-744-5040 405=744=7113
Purchase Order No.: direct to Ms. Diane Jones
Notation:

Date Received: May 7, 2001
General Description: Meals, varied
Date FAXed: May 30, 2001
Date Reported: May 30, 2001

ESCL #	4456	4456R†	4457	4457R
UNITS	W/W%†	W/W%	W/W%	W/W%
OSU #	BULLA		KOCHO	
Taurine	0.09	0.10	0.10	0.10
Hydroxyproline	0.00	0.00	0.01	0.01
Aspartic Acid	0.09	0.09	0.13	0.13
Threonine	0.03	0.03	0.04	0.04
Serine	0.04	0.04	0.05	0.05
Glutamic Acid	0.11	0.11	0.14	0.14
Proline	0.03	0.03	0.05	0.05
Lanthionine	0.00	0.00	0.00	0.00
Glycine	0.05	0.05	0.08	0.08
Alanine	0.06	0.07	0.09	0.09
Cysteine	0.02	0.02	0.02	0.02
Valine	0.06	0.06	0.08	0.08
Methionine	0.02	0.02	0.03	0.03
Isoleucine	0.04	0.04	0.06	0.06
Leucine	0.08	0.08	0.11	0.11
Tyrosine	0.02	0.02	0.03	0.03
Phenylalanine	0.05	0.05	0.07	0.07
Hydroxylysine	0.00	0.00	0.00	0.00
Histidine	0.02	0.02	0.03	0.03
Ornithine	0.01	0.01	0.01	0.01
Lysine	0.06	0.06	0.08	0.08
Arginine	0.05	0.05	0.07	0.06
Tryptophan	<0.04	<0.04	<0.04	<0.04
Total -->	0.93	0.95	1.28	1.27
Crude Protein	0.95	0.97	1.45	1.46
Crude Fat	0.21	0.19	0.18	0.11
Carotenes	30.0 µg/100g*	34.2 µg/100g*	15.0 µg/100g	17.3 µg/100g

† Abbreviations: ***W/W% or %, weight/weight percent, or gram/100 gram sample*** (all are equivalent); ***ppm, parts per million; IU. international units; mg, milligrams; mcg or µg, microgram; nd, not detected; R,*** duplicate run. Unless indicated otherwise, all data are presented on an '***as is***' basis.

* Major chromatographic interference in this sample (inorganic, probably). Reasonable attempt to modify the AOAC methodology did not remove the interference. All did show the carotenes to be a minor constituent and to be the values reported +/- 10% NIST value.

ESCL College of Agriculture • UMC
Experiment Station Chemical Laboratories

University of Missouri-Columbia Room 4 Agricultural Building Columbia, Missouri 65211

Sender: Dr. Gail Gates
Company: Nutritional Sciences Department, Oklahoma State University, 425 HES Building, Stillwater, OK 74078
Phone/FAX: 405-744-5040 405=744=7113
Purchase Order No.: direct to Ms. Diane Jones
Notation:

Date Received: May 7, 2001
General Description: Meals, varied
Date FAXed: May 30, 2001
Date Reported: May 30, 2001

ESCL#	4458	4458R†	4459	4459R
UNITS	W/W%†	W/W%	W/W%	W/W%
OSU #	CORN		FABA	
Taurine	0.09	0.09	0.08	0.08
Hydroxyproline	0.02	0.01	0.00	0.00
Aspartic Acid	0.50	0.49	3.17	3.13
Threonine	0.27	0.26	1.09	1.11
Serine	0.31	0.30	1.13	1.18
Glutamic Acid	1.79	1.80	4.34	4.27
Proline	0.77	0.79	1.00	0.99
Lanthionine	0.00	0.00	0.00	0.00
Glycine	0.32	0.31	1.03	1.01
Alanine	0.60	0.60	1.12	1.11
Cysteine	0.21	0.20	0.27	0.28
Valine	0.43	0.43	1.49	1.44
Methionine	0.16	0.16	0.33	0.32
Isoleucine	0.32	0.31	1.30	1.26
Leucine	1.03	1.03	2.27	2.25
Tyrosine	0.26	0.25	0.81	0.83
Phenylalanine	0.43	0.42	1.58	1.55
Hydroxylysine	0.00	0.00	0.01	0.01
Histidine	0.28	0.27	0.89	0.87
Ornithine	0.01	0.01	0.04	0.03
Lysine	0.25	0.24	1.90	1.88
Arginine	0.40	0.39	2.19	2.17
Tryptophan	0.06	0.07	0.30	0.29
Total –>	8.51	8.43	26.34	26.06
Crude Protein	8.77	8.86	28.44	28.16
Crude Fat	3.58	3.16	1.20	1.17
Carotenes	137.4 *µg/100g*	141.5 *µg/100g*	<2.0 *µg/100g*	<2.0 *µg/100g*

† Abbreviations: ***W/W% or %, weight/weight percent, or gram/100 gram sample*** (all are equivalent); ***ppm, parts per million; IU. international units; mg, milligrams; mcg or µg, microgram; nd, not detected; R,*** duplicate run.
Unless indicated otherwise, all data are presented on an '***as is***' basis.

ESCL College of Agriculture - UMC
Experiment Station Chemical Laboratories

University of Missouri-Columbia Room 4 Agricultural Building Columbia, Missouri 65211

Sender: Dr. Gail Gates
Company: Nutritional Sciences Department, Oklahoma State University, 425 HES Building, Stillwater, OK 74078
Phone/FAX: 405-744-5040 405=744=7113
Purchase Order No.: direct to Ms. Diane Jones
Notation:

Date Received: May 7, 2001
General Description: Meals, varied
Date FAXed: May 30, 2001
Date Reported: May 30, 2001

ESCL #	4460	4460R†	4461	4461R
UNITS	W/W%†	W/W%	W/W%	W/W%
OSU #	CHICKPEA		PUMPKIN	
Taurine	0.07	0.07	0.09	0.08
Hydroxyproline	0.00	0.00	0.06	0.06
Aspartic Acid	2.72	2.72	0.86	0.82
Threonine	0.78	0.79	0.17	0.16
Serine	0.94	0.99	0.20	0.19
Glutamic Acid	3.97	4.01	0.94	0.89
Proline	0.86	0.87	0.19	0.18
Lanthionine	0.01	0.01	0.02	0.02
Glycine	0.90	0.90	0.23	0.22
Alanine	0.99	0.98	0.35	0.34
Cysteine	0.35	0.35	0.11	0.10
Valine	1.11	1.09	0.30	0.28
Methionine	0.35	0.35	0.09	0.08
Isoleucine	1.03	1.01	0.27	0.25
Leucine	1.82	1.81	0.35	0.33
Tyrosine	0.64	0.63	0.15	0.15
Phenylalanine	1.48	1.48	0.26	0.24
Hydroxylysine	0.01	0.01	0.00	0.00
Histidine	0.65	0.64	0.15	0.14
Ornithine	0.03	0.03	0.01	0.01
Lysine	1.57	1.56	0.31	0.29
Arginine	2.59	2.55	0.26	0.25
Tryptophan	0.31	0.31	0.07	0.07
Total -->	23.18	23.16	5.44	5.15
Crude Protein	24.48	24.54	7.14	7.13
Crude Fat	5.40	5.40	2.46	2.31
Carotenes	235.6 *µg/100g*	248.7 *µg/100g*	11.2 *mg/100g**	11.3 *mg/100g**

† Abbreviations: ***W/W% or %, weight/weight percent, or gram/100 gram sample*** (all are equivalent)***; ppm, parts per million; IU. international units; mg, milligrams; mcg or µg, microgram; nd, not detected; R,*** duplicate run.
Unless indicated otherwise, all data are presented on an '***as is***' basis.
*note: this is to emphasize that the measure indicated is 'milligram' per 100 gram sample.

Report Approved: Thomas P. Mawhinney 5-30-01
Dr. Thomas P. Mawhinney, Director Date

Appendix J

Sensory Evaluation Questionnaire

Sample_____ Center_____ Date _____/_____/ 2002

1 Direction: Please give accurate responses based on the interview question
2 Child's food preference

Attributes	Like	Dislike
2.1 Please feed your child and tell us if your child likes it		
2.2 Did the child ate all the food served		
2.3 Does your child appear to have a second serving?		

3 Mother's Preference: Please tell us how much you like the following attributes of the food

Attributes	Like a lot (5)	Like a little (4)	Neither like nor dislike (3)	Dislike a little (2)	Dislike a lot (1)
3.1 Look at the food and tell us how much you like appearance					
3.2 Smell the food and tell us how much you like it					
3.3 Taste the food and tell us how much you like it					
3.4 Tell us if you like the consistency for swallowing					

4. Demographic: Please tell us your and your child's age (Child's age is to be recorded in months)
   4.1 Mother's age (yr.) <18 [ ] 18-25 [ ] 26-35 [ ] 36-45 [ ] 46-55 [ ] >55 [ ]
   4.2 Childs age (mo.) <12 [ ] 12-36 [ ] 37-48 [ ] 49-60 [ ]
5 Familiarity: Please tell us how many times in a week you feed your child with these foods

Food items	< 1 time	Number of times in a week	In what form do you give o the child. List all the methods of preparation.
5.1 Corn			
5.2 Faba bean			
5.3 Kocho			
5.4 Pumpkin			

6. At what time did your child has his/her last meal ____AM ____PM

7. Child's food intake

7.1 Please give the left over to the interviewer	Weight of served food (g)	Left over (g)

8. Preparation ability of parents

	Yes I can	No I can not
Can you measure and mix the food ingredients as taught		
Can you prepare the complementary food as taught		

9 Purchase intent if the food was available packed would you buy it [ ] yes [ ] No

9.1 How often would you feed this product to your child if the price was not a consideration	
A. I would feed these product to my child on every opportunity	[ ]
B. I would feed these product to my child often	[ ]
C. I would feed these product to my child once in a while	[ ]
D. I would hardly feed these product to my child	[ ]
E. I would feed these product to my child only if there were no other food choices	[ ]

9.2 Reasons for not purchasing: If not willing to buy please indicate your reasons	
A. I can not afford	[ ]
B. I have no time to prepare it	[ ]
C. I don't need it	[ ]
D. Other	

9.3 Suggested price: what price would you suggest for a 250 Grams food mixture for your child	
A. 20-40 cents	[ ]
B. 50-60 Cents	[ ]
C. 70-100 cents	[ ]
D. Other	

10 Follow up Questions

A. Did your child has problem after he/she ate the food? [ ] Yes [ ] No
B. What was the problem? A. Diarrhea B. Vomiting C. Stomach Cramps D. Other
C. How long after feeding did the problem appeared? A. <1 hr [ ], B. 1-3 hr [ ], C. 4-6 hrs [ ]
D. Other _____

Appendix K

Questions for Ministries of Agriculture and Health Professionals

Interview Questions

Questions for Institution Representatives

1. What goals of the ministry are related to improving the nutritional status of under five children?
2. In your opinion what are the main nutrition related problems of under five children
3. What specific nutrition related policy do you recommend to improve the nutritional situation of under five children
4. In your opinion what are the strong and weak points of nutrition intervention programs which you are aware of?
5. What type of strategies do you suggest for increasing the involvement of communities in nutrition intervention programs

Thank you for your participation

Appendix L

Summary of Suggestions from Ministry of Agriculture Professionals

Questions	Responses
What goals of the ministry are related to improving the nutritional status of under five children?	-Ensuring increased household food security through improved crop and animal production so as to sustain adequate household nutrition. -Delivering of extension messages on improvement of traditional food preparation, personal and environmental health, population and family planning, promotion of income generation and appropriate technologies aimed at women and children. -In-service training for development workers to improve services provided to rural people. -Increasing awareness through education
In your opinion what are the main nutrition related problems of under five children in Ethiopia?	-Low attention to improving the nutritional status of children -Lack of nutrition intervention projects aimed at local food resources -Lack of knowledge on efficient food preparation to prevent nutrient loss -Poverty and food insecurity -Existing food taboos and cultural influences limiting children from getting some foods -Deficiency diseases such as Kwashiorkor, Marasmus and Vitamin A deficiency, which are severe mainly in the rural children. -Lack of clean drinking water resulting to diarrheal diseases and increased health complications. -Weak children exposed to health complications. -Increased child mortality.
What specific nutrition related policy do you recommend to improve the nutritional situation of under five children in Ethiopia?	-Adequate training on improved child nutrition and feeding practices based on local food resources. -Strengthening extension message delivery systems -Ensuring adequate household food security -Strengthening development strategies aimed at poverty alleviation. -Strengthening applied research on food resources, which could be ideal foods for promoting child health and development. -Development and testing of recipes using beneficial local food resources and training community members, mainly mothers. -Strengthening service delivery systems such as schools, health care, and availability of clean drinking water to promote child health, physical and intellectual growth.

In your opinion what are the strong and weak points of nutrition intervention programs which you are aware of?	-Lack of strengthened support for children aimed activities. -Having services which creates a long lasting dependency -Intervention efforts are not based on local food resources and lack strong research support, which leads to poor sustainability. -Lack of realistic training strategy for training rural community mainly women. -Lack of communication and integrated effort between service delivery organizations -Biased opinion on gender which leads to leaving child related concerns to women only -*Strong point*: existence of Rural Women's Bureau with extended structure to reach grass root level. -Increased support to promote development project aimed at the community -Effort to include simple techniques in teaching rural communities.
What type of strategies do you suggest for increasing the involvement of communities in nutrition intervention programs?	-Promoting and creating awareness on the fact that childcare activities are not the responsibility of females only rather it needs to be supported with well-defined educational programs. -Realizing the fact that a productive society cannot be guaranteed without healthy children, this further requires full support of government and non-government organizations. -Strengthening community participation with due attention to improving deficiencies of local practices. -Promoting selective crop and animal production known to improve the nutritional status of children. -Increasing awareness to stop harmful traditional practices and food taboos.

Appendix M

Summary of Suggestions From Health Professionals

Questions	Responses
What goals of the ministry are related to improving the nutritional status of under five children?	- Delivery of vaccination and family planning services in outstation programs. - Screening of at risk children for malnutrition. - Existence of twins program and provision of powdered milk and cereal mix to mothers with twins. -Feeding program for severely malnourished under five year old children and parental training on child feeding
In your opinion what are the main nutrition related problems of under five children in Ethiopia?	-Lack of adequate and nutritious diet appropriate for the health of children. -Lack of birth spacing and competition for limited food resources.
What specific nutrition related policy do you recommend to improve the nutritional situation of under five children in Ethiopia?	-Health and nutrition education -Sustainable development projects.
In your opinion what are the strong and weak points of nutrition intervention programs which you are aware of?	-Strong points: delivery of MCH service on a weekly basis -Areas of improvement: - The service needs to be integrated - Family planning service needs to be given. - A need for a nutritionist
What type of strategies do you suggest for increasing the involvement of communities in nutrition intervention programs?	-Health education programs needs to be strengthened. -Need for family planning programs -Promotion of community-based approaches -Intersectional collaboration with different organizations (eg. MOA and MOH). -Education on importance of breakfast for children (it was reported that students go to school without breakfast and sleep in class).

VITA

Yewelsew Abebe

Candidate for the Degree of

Doctor of Philosophy

Dissertation: NUTRITIONAL STATUS OF LOW INCOME MOTHERS AND UNDER-FIVE CHILDREN IN SOUTHERN ETHIOPIA: FOCUS ON TRANSITIONAL FOOD DEVELOPMENT

Major Field: Human Environmental Sciences

Area of Emphasis: Nutritional Sciences

Biographical:

Education: Received a Bachelor of Science degree in Family Resources from West Virginia University, Morgantown, West Virginia in May 1986; received Master of Science degree in Family Resources from West Virginia University, Morgantown, West Virginia in August, 1987. Completed the requirements for the Doctor of Philosophy degree in Nutritional Sciences in August 2003.

Experience: Field Extension development agent under the Ministry of Agriculture Ethiopia from 1974-1976. Teaching Assistant, Awassa Agriculture College, Debub University Ethiopia from 1976-1983. Instructor at the Rural Development and Family Sciences (RDFS) Department, Debub University Ethiopia from 1988-1998, Chaired the Rural Development and Family Sciences Department for about seven years.

Professional Memberships: Society for Nutrition Education, African Home Economics Association, and Ethiopian Family Guidance Association.