MARKETING FEASIBILITY OF A NUTRITIONALLY ENHANCED PASTA

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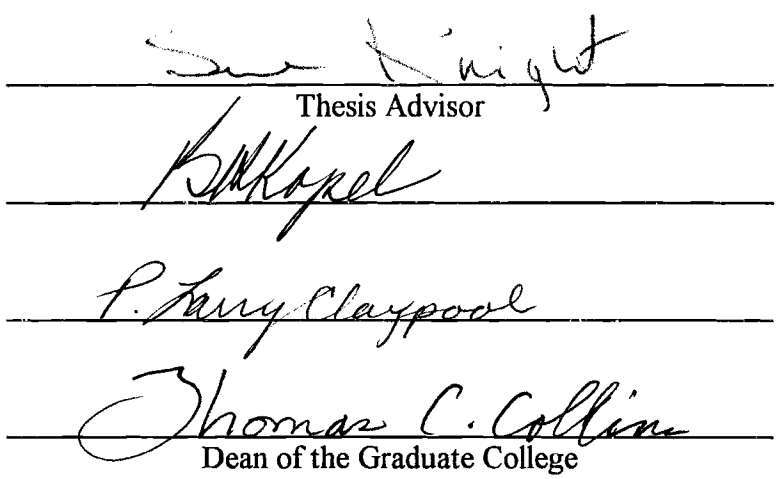

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CHAPTER I

INTRODUCTION

The consumption of pasta in the United States is steadily increasing; and the food industry is launching several new products such as modified atmosphere packaged pasta, no boil pasta, and pasta designed for use in retorts and microwave ovens. Pasta is not a modern food stuff but ancient. There are evidences indicating some form of wheat and water mixtures were consumed in prehistoric Mesopotamia but the earliest record of pasta as such was in 1279 where it was included in a will. Also there are records showing that Marco Polo brought noodles or macaroni from China to the Western world when he returned in 1295. One more early reference to pasta was made by the Italian writer, Boccaccio. So in the past 700 years pasta has been produced in one form or another. It is still being produced but with much different technology (1).

Any diet that relies heavily on a single food such as wheat, rice, corn, cassava, or any other staple, will lack the variety necessary for good nutritional balance. Therefore fortification of staple foods is an area of technology that has had a great impact upon the health of the consumer. The concept of fortification started in 1833 in South America with the addition of iodine to table salt to prevent goitre. Since then various foods have been fortified with nutrients. These include margarine with vitamin A, milk with vitamin A and

D, bread with thiamine, riboflavin, niacin and iron; enrichment of degerminated cornmeal, corngrits, whole grain cornmeal, rice, pasta products and cereals (2).

Wheat gluten, the major protein in pasta, is inadequate as a total dietary protein, mainly because it has insufficient amounts of two essential amino acids, lysine and threonine. But legumes are a good source of these two proteins. So adding legume flour in pasta products is an economical method of improving the protein quality. However, since legumes are only about 23% protein (ranging from 11% for lima beans to 37% for soy), it is difficult to greatly increase protein levels since legume flours can only by substituted at the levels of 5-15% without losing acceptability (3). Still the simple basic formula of pasta and its use as a major food in many cultures makes it good target for fortification.

In the United States one of the major groups suffering from malnutrition is the elderly, particularly the institutionalized elderly. Fortification may be one of the solutions to correct malnutrition among the elderly. According to Rudman and Feller (4) 5% of the American population aged 65 years and older is being housed in nursing homes. They found that nutrition plays an important role in maintaining health and improving the quality and length of life in the geriatric group. They also recognized that nutritional problems can be more severe if these individuals are limited to a soft diet. Further by the year 2025, about 3.1 million elderly Americans will live in nursing homes (4). However, the demand for a nutritionally enhanced food such as a fortified pasta that is enjoyable and easily eaten has not been sufficiently documented.

PURPOSE AND OBJECTIVES

The purpose of this research is to assess the marketing feasibility of a pasta nutritionally enhanced with protein and calcium by conducting a mail survey of Oklahoma nursing home operators. This nutritionally enhanced pasta was developed in the Department of Nutritional Sciences at Oklahoma State University specifically for use by elderly people.

The objectives of this study are as follows :

1. To determine nursing home operators' use of protein and calcium supplements for frail elderly and what they use.
2. To determine the type of pasta served and the frequency of serving pasta in the nursing home.
3. To determine whether the nursing home operators indicate an interest in and/or a willingness to purchase and serve the nutritionally enhanced pasta in addition to or in place of their currently used dietary supplements.

ASSUMPTIONS

This study was planned on the following underlying assumptions.

1. The developed questionnaire is a valid instrument in assessing the marketing feasibility of the nutritionally enhanced pasta.
2. All responses are answered voluntarily and truthfully by the respondents.
3. The respondents are responsible for making food purchasing decisions in the nursing homes.

4. The data will be useful in manufacturing the nutritionally enhanced pasta on a large scale basis.

LIMITATIONS

1. The data were limited to the nursing homes that were registered with the Oklahoma Department of Health during the study period.

2. The subjects were limited to the operators of the nursing home facilities and further to those nursing home operators who responded to the survey.

3. Results of this study were limited to those who responded and cannot be extrapolated to the population as whole.

DEFINITION OF TERMS

Central kitchen: A standard kitchen that prepares and serves food within a single facility.

Exotic pasta : Pastas other than spaghetti, macaroni and noodles. This includes lasagna, rotini, etc.

Frail elderly: An elderly person who cannot live independently and is at a high risk for severe disability (39).

Goitre: Iodine deficiency disease affecting the thyroid glands; can be prevented in areas where iodine levels are low by adding it in small amounts to a common food such as table salt (5).

Nursing home operators: Owner or manager of the home or their delegated representatives.

Nutitionally enhanced pasta: Refers specifically to a product developed at Oklahoma State University which provides as much protein as in a whole egg and as much calcium as in a glass of milk without any toppings added to it.

Osteoporosis: Osteoporosis (porous bone) is the clinical syndrome resulting when over one third of the bone is lost. This is a most common disorder among the elderly and usually characterized by decreased bone mass with no change in the chemical ratio of mineral to protein matrix. Existing bone is normal, there is just less of it (6).

Pasta: Alimentary paste composed primarily of flour and water, usually prepared from the semolina of durum wheat. Can be extruded or cut into various shapes (spaghetti, macaroni, noodles). May contain eggs, but egg noodles must have a minimum of 5.5% egg solids (15).

Protein-Calorie malnutrition (PCM): Also called protein-energy malnutrition, is a condition when both dietary protein and calories are deficient . PCM is characterized by ketosis whereas protein deficiency alone is not (5).

Satellite service: Food is prepared in a separate facility and transported to one or more food service units.

CHAPTER II

REVIEW OF LITERATURE

HISTORY OF PASTA

Art, architecture, technology, and food are expressions of every culture. Much of our understanding about Italian Renaissance comes from works of great artists such as Michelangelo and Giotto Ghilberti; and the culinary lessons inherited from the Italians are relevant in modern society as well, since the Italians were also leaders in the fine art of dining and in well prepared cuisine (7).

Pasta is usually recognized as Italian food, but in fact, it did not originate in Italy. The origin of pasta is somewhat obscure. There are proofs that the cultivation of wheat and it's utilization in some pulverized form was existent in Mesopotamia about 2000 B.C. About this time the Egyptians also utilized wheat for bread baking and various forms of pasta products. According to Matsuo (8) some historians claim that pasta began in the Middle-East and spread east through India and on to China and Japan and finally to the west through Greece into Italy and the rest of Europe. Others say that noodle products were known in China about 500 B.C.

According to legend, the famous Italian explorer, Marco Polo, upon his return from China, first introduced pasta products to Italy in the Thirteenth Century. Another legend is that a Chinese maiden, while bread making, was interrupted by her Italian sailor

friend. The bread dough spilled out of the pan and dripped in strings from the work bench. The Italian sailor took the dried dough back to the ship where the cook boiled the dried dough in broth. They found it to be delicious and prepared it for the crew. The noodles were hard to eat without a chopstick, so the Italians developed other forms of pasta like macaroni, lasagna, and egg noodles (9).

Another version for the history of pasta was that ships needed to carry enough non-perishable foods to last for several months, even years. This required a food which could be stored without spoilage or deterioration for very long periods. Macaroni products if stored dry, could be kept at room temperature for several months with little or no deterioration in either nutritional or aesthetic quality. Therefore, these products were handy in long voyages. Macaroni products have survived the test of time and remain a popular food of modern day society (10,11,1).

Around the globe about 600 different forms of noodles are available of which 150 variations are commercially marketed in the United States. According to the National Pasta Association, the average American consumed almost 19 pounds of dry pasta in the year 1992. Pasta was brought to the United States by Thomas Jefferson in 1789, who served as an ambassador to France. Fifty nine years later the first American pasta factory was opened by a Frenchman in Brooklyn (12). According to the market research firm Frost & Sullivan, Inc., of New York, pasta sales continue to increase steadily with sales projected to rise from $ 1.52 billion in 1988 to $ 1.66 billion in 1992 (13).

NUTRITIONAL VALUE OF PASTA

Cereal foods have a very important place in the Nation's diet. Over 8 million tons/year of cereals are consumed by the food industry. Bread is the main form of cereal consumption, but also other cereal products are gaining popularity among the consumers. Whole meal pasta products have shown a three fold increase in consumption since 1982 (14).

Pasta is considered as a healthy food because it is low in fat and high in carbohydrate. The mild flavor of pasta is very acceptable and that is the reason for its popularity. There is no more painless way to get complex carbohydrate than to eat pasta. Even refined flour pasta is rich in complex carbohydrates (15).

Table I shows the composition and energy content of a typical dry pasta. As seen in Table I, dry pasta is 10 to 11% protein. Table II compares the amino acid composition of the protein in dry pasta to the Food and Agricultural Organization model composition (15).

MANUFACTURE OF PASTA

Traditionally semolina of durum wheat is the primary ingredient in pasta, because durum's high gluten content produces a tough and elastic dough. The main ingredients of pasta are semolina and water and, if desired, other forms of hard wheat can be added. Flavorings, vegetable purees, or eggs may be blended in with the water, or the semolina mix may be seasoned with herbs and spices. Egg noodle products must contain a minimum of 5.5% egg solids. After the dough is kneaded it is extruded through dies of

TABLE I

COMPOSITION AND ENERGY CONTENT OF DRY PASTA (15)

		Energy/100g	
	g/100g	Kcal	%Kcal
Moisture	12.5	—	—
Protein	10.5-11.5	46	13
Lipid	0.8-1.0	11	3
Carbohydrate	74-75	293	84
Ash	0.60-0.85	—	—
Total		350	100

varying shapes and configurations. A revolving knife cuts the dough into lengths. After this it is dried. Pasta dried too fast will be brittle and if dried too slowly it will spoil (17). A scheme for continuous manufacture of pasta is given in Figure 1.

FORTIFICATION

Nutrition is fundamental to life, work, and well being. Among the world's population malnutrition plays a part in a substantial numbers of deaths. Further, inadequate diets and related illnesses interfere with learning ability, capacity to work, behavior, and well being. Malnutrition is mainly caused by insufficient amounts of foods

TABLE II

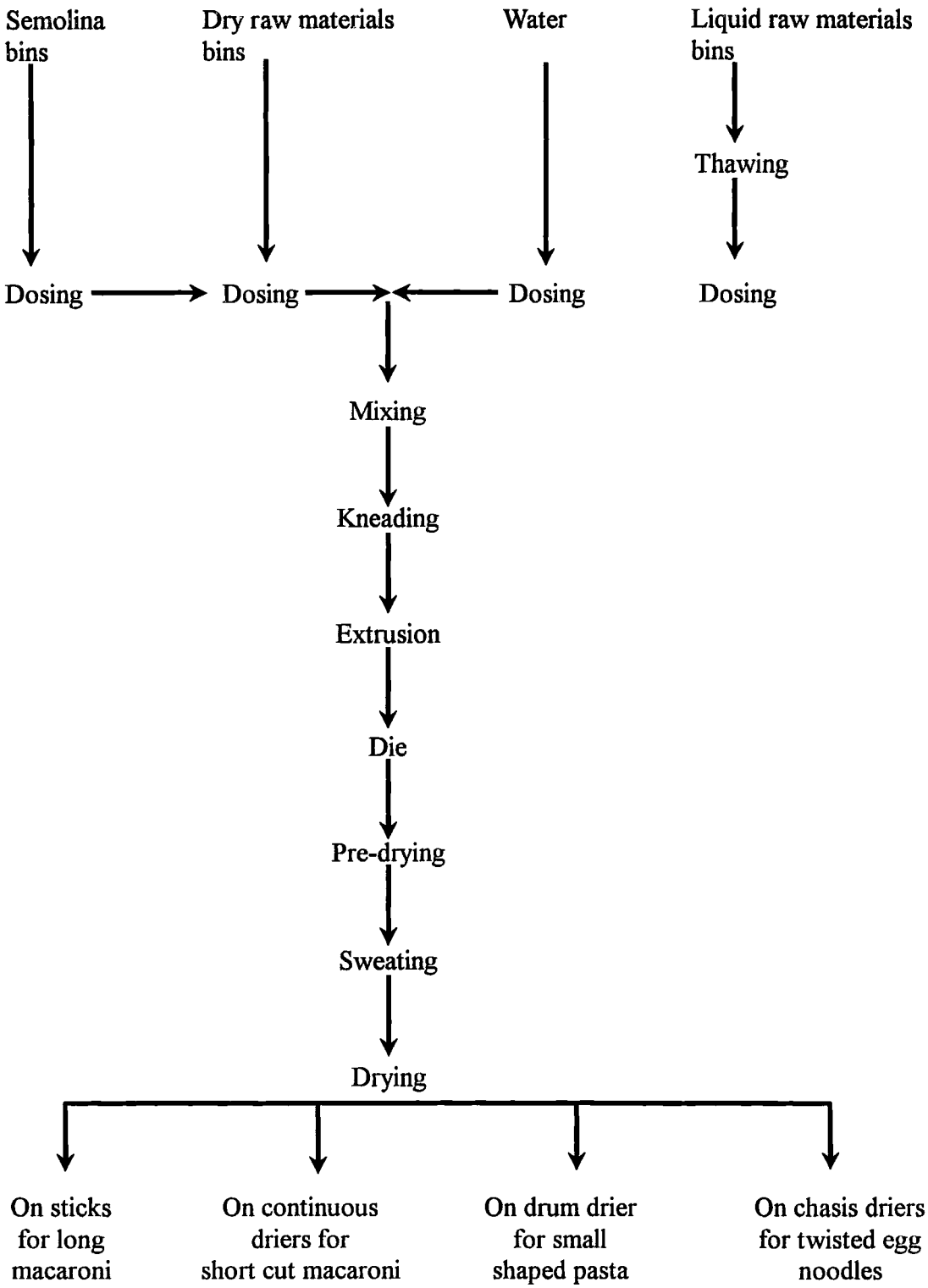
Amino Acid Composition: Dry Pasta Vs FAO Model Composition (15)

Amino acids	g/16 g N	
	Pasta	FAO model composition
Isoleucine	4.0	4.0
Leucine	7.16	7.0
Lysine	2.57	5.5
Methionine	1.66	___
Cystine	2.08	___
Sulphur amino acid total	3.76	3.5
Phenylalanine	4.45	___
Tyrosine	2.90	___
Total aromatic amino acids	7.35	6.0
Threonine	3.10	4.0
Tryptophan	1.45	1.0
Valine	4.90	5.0

with inadequate nutrients. Many interventions have been implemented to overcome this, but malnutrition remains a problem (18).

Several countries have investigated the use of low cost, commonly consumed, high quality foods prepared from inexpensive local plant sources to meet the daily

Figure 1. Continuous manufacturing process (16).



nutritional requirement. The quality of a food deficient in any particular nutrient can be made nutritionally adequate by fortifying the food with the missing nutrient. The lack of one or more nutrients in a staple food may lead to several problems. For example, if a primary protein source has a low concentration of one or more essential amino acids, the efficiency of utilization of all the other amino acids is limited. If a single essential amino acid is missing, vital proteins cannot be synthesized, which results in impaired growth or even death (19).

Cereals play a major role in supplying the needed proteins in the human diet. Cereals supply over 50% of the human food in the world, but their protein content is low and incomplete in certain essential amino acids. Even in the United States, where consumption of meat and dairy products is high, the consumption of cereals are expected to increase in the future. Wheat can be incorporated in diets in many different forms; therefore, it has great potential for new or expanded food uses. Since cereals are expected to play a major role in the future diet, improved nutritional value of cereal based food products must be considered. A way to achieve this is to fortify wheat based foods such as bread and pasta (20).

Fortification is when ingredients not normally found in a food are added to effect a specific dietary purposes (21). One good example of low cost fortification is by single cell protein. Single cell protein has no dependency on agricultural input or other harvesting operations. Single cell protein has been suggested for use as an extender in frankfurters or other fabricated foods, and as a protein enhancement of baked goods (22).

Fortification by Enrichment

Fortification can be defined simply as the addition of nutrients to food. The term enrichment is used to describe a special type of fortification practiced under these circumstances quoted from Ranum (23) :

1. The enriched food should be a dietary staple like wheat flour, cornmeal, or rice. These are excellent vehicles for getting nutrients to the population.
2. Nutrients present in significant levels in unprocessed foods can be lost during processing, such as milling. This can be made up by adding the lost nurtient.
3. There must be good evidence that the enriched nutrient is in short supply within the target population and there must also be evidence of need for the nutrient.
4. The enrichment should be invisible. That is it should cause no changes in the originality of the food such as appearance, flavor, or even the price of the food.

In enrichment amounts added are designed to meet specific legal standards of minimum and maximum levels of nutrients. A good example of enrichment is the addition of specific amounts of three B vitamins and iron to white flour and other cereal products (23).

Fortification of Pasta

Several researchers have tested fortification of pasta with proteins and found it to be successful (24,25,26,27,28). Schoppet et al. (29) added whey protein from cottage cheese as a means of fortifying pasta that met the standards set for the USDA School Lunch Program. Schoppet, et. al. (30) also used cheese whey proteins, harvested along with yeast cells grown in the whey, to increase the protein content of macaroni. They also used dried casein alone for the same purpose. Both fortifications resulted in an increase from 13% to 20% protein and also increased protein efficiency.

Bahnassey, et. al. (31) fortified spaghetti with nonroasted and roasted legume flours and legume protein concentrates. They found that fortified spaghetti had superior nutritional properties to spaghetti made from 100% durum semolina, demonstrating that cereal-legume blends have a better nutritional balance.

Duszkiewicz-Reinhard, et. al. (32) fortified spaghetti with legume flours and legume protein concentrates and increased the protein content of spaghetti to the point that it met the FDA standards. The spaghetti fortified with legume flour was preferred by the panelists over that fortified with legume protein concentrates.

Maga and Everen (33) fortified pasta with dried distillers grain (DDG). DDG is a major by-product from the fermentation of cereals in the production and distillation of alcohol. The starch from cereals serves as the yeast energy source during the fermentation process. Due to the loss of starch, other components, such as protein and fiber, are concentrated thus making the dried residue a potential food for humans. The DDG fortified pasta had superior fat, protein, fiber, and ash levels as compared to whole wheat pasta.

Chompreeda, et. al. (34) incorporated 7-21% defatted peanut and 4-12% cowpea flour to the wheat flour used to prepare Chinese type noodles. They found that this flour mixture increased the protein content in the noodles to 21% without excessively sacrificing color and firmness. They concluded that up to 15% peanut flour and 8% cowpea flour supplement produced acceptable Chinese noodles with high protein content (21%).

In India, Niturkar, et. al. (35) fortified vermicelli with dried skim milk at levels of 2, 4, and 6% protein respectively. They found that the 4% protein fortification level was optimum, yielding a satisfactory vermicelli.

Pasta can be nutritionally improved by the use of soy protein isolate. Duxbury (36) added powdered soy protein to the durum semolina and reported that the isolated soy protein is essentially bland in flavor and odor. Further soy protein isolate is highly digestible and is a concentrated source of protein (minimum 90%). The soy protein's essential amino acid pattern exceeds the "amino acid requirement patterns" for children and adults as published in the Food & Nutrition Board's Recommended Dietary Allowance,1989. Addition of the correct isolated soy protein can be used to create desired textures for retorting or fortifying purposes. Fortifying pasta with isolated soy protein is substantially more economical than with other protein sources, such as egg white (36). Sing and Chauhaun (37) supplemented durum semolina with 10% defatted soy flour in noodles and found that the protein content increased to 19% without any change in the acceptability of the product.

INSTITUTIONALIZED FRAIL ELDERLY

In United States there are about 3.25 million older Americans with physical frailty. This is a major cause of long term care needs. Estimated annual costs of physical frailty range from $54 billion to $80 billion. Unless better means are found to reduce frailty, by the year 2030, this problem could grow to over $132 billion (38).

The term "frail elderly" is familiar to all concerned with health care needs of older persons. A frail elderly person cannot live independently and is at a high risk for even more severe disability. This includes a variety of impairments such as severely diminished physical functioning, susceptibility to injuries and acute illness, and cognitive dysfunction (39).

In United States the elderly population is growing rapidly. In 1990, nearly 7 million people were 80 years or older. People 85 or older were one-tenth of the nation's elderly (i.e., 65 years or older) population in 1990. From 1960 to 1990, the number of persons 85 years and over increased 232% compared with an increase of 39% for the total population. The elderly population has a major impact on the nation's health and social service systems. The Bureau of Census projects that the worldwide increase in the population of elderly will be from 286 million in 1985 to 410 million in the year 2000 (40).

Low body weight and rapid unintentional weight loss are the main symptoms of mortality and morbidity in the elderly population. Acute and chronic diseases cause involuntary weight loss. Also psychiatric disorders like dementia and depression also result in nutritional deficiencies. Energy requirements decrease because of the lower basal metabolic rate and reduced physical activity of the elderly. These make it more difficult to

obtain adequate amounts of required nutrients. Another major problem is the chewing of food since many elderly suffer tooth loss(41).

Programs have been developed which stress community care in place of institutional care. One such program is "The Program of All-inclusive Care for the Elderly" (PACE). This was developed at On Lok in San Francisco's Chinatown. The main goal of PACE is to provide the frail elderly with care that improves or maintains participants' functional independence, enabling them to avoid institutional care (42).

Adult Day Care Centers are developing as an alternative to institutionalization. In Oklahoma there are 15 adult day care centers located in seven state cities and towns. Weekday mornings about 250 to 350 frail elderly Oklahomans are delivered to these centers. Even if each center were operating at its capacity only a few hundred clients can be accommodated. Ten years ago Oklahoma had exactly one such center, The Daily Living Center in Oklahoma City started in 1974. The major handicap for adult day care movements in Oklahoma is in not trying to get the support and attention of physicians. Oklahoma's daily living center's long time board member, Dr. Vivian Smith, and Muskogee's Brenda Mahoney, an RN, have put great effort into the development of Day Care Centers in Oklahoma (43). However, such community care programs are not available or are inadequate for many elderly people so institutional care cannot be avoided.

Institutional long term health care in the United States is provided in places generally called nursing homes. They are defined in a broad way as institutions providing rehabilitation, nursing care, or personal care. The clients are persons who require institutional services below the level of hospitals and above the level of room and board.

which is a growing population, are the greatest users of the nursing homes. Therefore, the use of nursing home care by the oldest old has major implications for the future of the nation. About 8% of the health care dollars in the United States spent on nursing home care is provided by the federal government, mainly through the Medicaid program (44).

The prevalence of institutionalization and functional disability in old age is very important. Due to the increased health care problems, postponing mortality without preventing or delaying morbidity will increase the burden of providing care to the elderly because of the increase in the number of people in nursing homes or in the community with functional disabilities. According to the current projections there will be 3.1 million residents of nursing homes in 2025 (45).

Sullivan, et. al. (46) have determined that malnutrition is the leading cause for increased mortality among elderly patients. Keller (47) determined the prevalence of undernutrition and overnutrition in long term health care elderly patients and the functional, behavioral, environmental, nutritional, and medical variables associated with this prevalence. He found that undernutrition exists at a higher level but not unusual for the institutional setting. Undernutrition appears to cause more nutritional disorders than overnutrition, and he suggests that efforts should be made to decrease undernutrition among the institutionalized elderly.

According to Silver, et. al., (48) nutritional risk factors are similar among different age groups in nursing home patients. Further they found that there is less evidence of malnutrition among patients in an academic nursing home compared with other nursing home settings.

PROTEIN CALORIE MALNUTRITION IN INSTITUITIONALIZED ELDERLY

Protein calorie malnutrition is prevalent among nursing home residents. The causes of protein calorie malnutrition in the nursing home include inability and/or unwillingness to eat, which in turn are the manifestations of neurogenic dysphagia, anorexia caused by brain disease, emotional depression, anorexgenic drugs, poor dental status, the loss of taste and smell, or environments that may not be conducive to eating. Also infections may aggravate the situation (49).

The contribution of protein calorie malnutrition to increased morbidity and mortality in various clinical settings remains controversial. Agarwal, et. al (50) found that both acute-care hospital and nursing home patient populations have demonstrated a correlation between the level of specific clinical markers of nutrition status and the risk of subsequent morbid events.

Sullivan, et.al. (51) have studied whether the level of protein-calorie malnutrition at presentation correlated with the subsequent risk of developing in-hospital complications independently of nonnutrition factors influencing outcomes. They found that nutrition is independently correlated with the risk of developing infectious complication or a major life threatening complication and dying within the hospital. This study indicates the importance of nutrition status in geriatric rehabilitation particularly the importance of increasing total calories as well as protein in the diet..

Protein-calorie deficiencies may be more prevalent than records show. Mowe and Bohmer (52) determined the extent to which elderly patients with severe signs of malnutrition had been diagnosed as such and the diagnosis documented in the medical

records. They found that malnutrition is underdiagnosed and undertreated. This may lead to an insufficient understanding of the factors which contribute to disease and disability in the elderly and to inappropriate health planning since, in their study, 50% of the hospitalized patients showed the presence of protein-calorie malnutrition. However Mowe and bohme report that this was not documented in the hospital records.

CALCIUM

Calcium constitutes a significant part of the mass of teeth and bones. Calcium in minute concentration is necessary for normal blood clotting. Calcium helps to regulate the contraction of muscles and the transmission of impulses along the nerves. Osteoporosis, seen among elderly, is a condition in which the rate of breakdown of bone material exceeds the rate at which new bone material is formed. The eventual result is that bones become porous and fractures easily. Inadequate intake over a period of many years is one of the factors in the occurrence or severity of this disease among elderly (53).

In both men and women, aging results in poor absorption and extra calcium may be needed. In particular, women with the advent of menopause experience considerable loss of bone mass although hormone replacement treatment can stem this loss (54). Wardlaw (55) recommends an increase in the dietary calcium to 1500 mg per day to compensate calcium loss in elderly women, those not on estrogen. Chapuy et al. (56) showed that supplementation with vitamin D-3 (120 μg) and calcium (1.2g) reduces hip fractures and other non vertebral fractures among elderly women.

protein intake. By increasing the calcium intake, the effect of protein can be easily offset by improved absorption efficiency. Dietary protein, particularly pure protein, affects calcium status, but there is a need to increase protein intake in the elderly. This could affect diets that are already calcium deficient (55).

ADDRESSING THE PROBLEM

Krinke (58) suggests that nutrition education could help in promoting the health of elderly persons. Nutrition educators who communicate the benefits of nutrition through the print media and through work with physicians treating older adults will have the best chances of promoting the health of older adults through better nutrition .

The demographic shift manifested by the growing elderly population in the United States will create the need and economic environment for the development of special food products for this segment of society, and texture is probably one of the most important factors, that will determine acceptability of such products. Sahyoun et al. (59) stated that half of the nursing home population they studied reported chewing, biting, and swallowing problems. In both men and women, having dentures negatively correlated with protein intake. Lower intakes of vitamins A, B-6, B-12, folate, magnesium, zinc, and phosphorous were significantly correlated with dental problems in elderly women. In men, dental problems were significantly correlated with low levels of intakes of energy and calcium per kilogram body weight.

Peleg (60) reports that as far as texture is concerned, difficulties in chewing by the elderly may rise because of the following :

1. The material requires a large force to break for example, nuts, candies, and carrots.

2. The material requires extensive mastication before swallowing, thus causing fatigue, for example tough meat, chewy granola bars, and dry fruits.

3. The material may be too dry and without sufficient salivation, hard to swallow for example, Swedish bread.

4. The material may adhere to teeth and dentures for example, dry fruits and candies.

5. Sharp broken pieces can cause injuries to the inner parts of the mouth.

In order to provide nutritionally enhanced, easily eaten food for the elderly, researchers at Oklahoma State University have developed a protein and calcium fortified pasta (25). Although others (31, 32, 34, 36, 37) report successful enrichment of pasta with legume flours, the Oklahoma State University team found that the sensory qualities of pasta were much better when eggwhite and caseinate were the primary sources of the protein fortification. Sensory studies (25) have established the product acceptability, and an animal feeding study has shown the nutritional efficacy of the pasta (24). However, the attitudes of nursing home managers about such a product was not determined.

SURVEYS

Jessen (61) states that surveying is the process in which the surveyor observes what is going on without disturbing it. He also calls the surveys "statistical" as they are based on samples rather than on complete coverage of the population of interest. Further

the sample selection should consist of a chance mechanism for random selection of samples, and objectivity of the researcher is important.

Rossi (62) traces the history of surveys and point out several high points. The populations of ancient settlements and national states, such as Rome or Athens, were known by their rulers and chroniclers in vague terms. The first modern survey was conducted by Booth in London using a block-by-block or household-by-household survey of London's poor. The first survey in United States was done on spotmaps of all of the locations of ill fame Chicago. Also in Chicago researchers attempted to map the location of juvenile gangs. Rossi (62) considers the first respectable surveys were conducted on Roosevelt-Landon presidential elections. In the 1930's the census bureau conducted an unemployment survey based on short questionnaires delivered by letter carriers, requesting anonymous postage paid mail return.

Adams (63) defines questionnaires as self-administered interview schedules. The recipient of the questionnaire who accepts the invitation to participate plays the dual role of interviewer and respondent, asking the question by reading it and then answering it by marking the preferred response. He also notes that survey by questionnaire is generally regarded as most economical. Another advantage is the anonymity offered by this technique, and the respondent will more freely answer the questions if they do not have to face the interviewer.

The limitation outlined by Adams (63) is that the response might well be returned by other persons than for whom it might be intended. This method is also the slowest technique for survey. The prevailing view, as seen by Adams, in the research community

is that a questionnaire should not be used unless every reasonable effort is going to be invested in obtaining a complete response.

The mean of a set of data is the sum of all values divided by the number of values. Median of a set of data is defined as the "middle" value when the measurements are arranged from lowest to highest. The variance of a data set is defined as the dispersion of the data from the mean. These measures indicate selected characteristics of the surveyed data. These measures can be used to distinguish one set of surveyed data from the other (64).

Surveyors are often faced with large quantities of data requiring analyses. Since it is difficult to grasp the total data picture from tabulations a useful first step in data analyses is to plot the data as frequency histogram. This is done by grouping the data into classes and then plotting a bar graph with the number or relative frequency of observations in a class versus class label. In some data a class represents an interval which represents the difference between upper and lower class boundaries (65).

CHAPTER III

METHODS AND PROCEDURES

The purpose of this study is to assess the marketing feasibility of nutritionally enhanced pasta by conducting a mail survey of Oklahoma nursing home operators. Specifically, the nursing home operators were asked to describe the size of the facility, type of food service, pasta products they use, frequency of pasta in their menu, source of pasta, their interest in the nutritionally enhanced pasta, whether they give protein supplements, how many receive protein supplements, type of protein and calcium supplement, if the clients tire of nutrient supplements, how much they are willing to pay for the pasta, and how much they are willing to serving the pasta to their clients.

The research design, population sample, data collection (which includes planning and development, instrumentation, procedures), and data analyses will be presented in this chapter.

RESEARCH DESIGN

The research method used in this study was descriptive research, which according to Borg (61), is concerned with conditions or relationships that exist; practices that prevail; beliefs, points of view, or attitudes that are held; processes that are going on; effects that are being felt; or trends that are developing. At times, descriptive research is con-

cerned with how what exists is related to some preceding event that has influenced or affected a present condition or event.

One of the classifications of descriptive research, survey research, is applied in this study. Survey research typically employs questionnaires and/or interviews in order to determine the opinions, attitudes, preferences, and perceptions of interest to the researcher. The questionnaire is used to collect basic descriptive information from a broad sample (56).

POPULATION

The population used in this study was the 390 registered nursing home facility operators in the State of Oklahoma. The addresses of all the nursing homes were obtained from a directory published by the Department of Public Health, Oklahoma. Each of these was mailed the research questionnaire.

DATA COLLECTION

Planning and Development

Planning and development began during the spring of 1994 and continued through the summer of the same year. Instrumentation and data collection procedures were determined and data analysis techniques appropriate to test the data were selected.

Instrumentation

The research instrument used in this study was developed by Palaniswamy and Dr.

Knight assisted by Drs. Kopel and Claypool. The developed survey was validated with 20 people who had survey background. With the help of their valuable suggestions appropriate changes were made. The validated survey was approved by the Institutional Review Board (IRB) at Oklahoma State University

Procedure

The questionnaire was printed on white bond paper and the cover letter was printed on letter head of the Department of Nutritional Sciences at Oklahoma State University. They were reproduced at the audio visual center in the Human Environmental Sciences at Oklahoma State University. The University's Central Mailing Services facilitated the mailing and return of the questionnaires. Postage was provided by the research fund. The cover letter and the questionnaire were folded and the addresses were printed by the Central Mailing Services; they were sent out in envelopes along with the return postage paid envelope. To assure complete anonymity, nowhere in the survey nor in the return envelope was the respondent's name mentioned. The 390 questionnaires were mailed on July 4, 1994. The time for the questionnaires to be returned was left to the discretion of the respondents. Due to time and financial constraints, no follow-up was done. Copies of the survey, cover letter, and the IRB approval form are included as Appendix I, Appencix II, and Appendix III.

Data Analyses

The questionnaires were coded and the data collected were entered for computer

assisted analyses using the Excel software program. Descriptive statistical procedures, using percentages and frequency tables, were used to analyze the data.

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this study was to assess the marketing feasibility of the nutritionally enhanced pasta developed in the Department of Nutritional Sciences at Oklahoma State University. Data were obtained using the research instrument described in Chapter III, Methods and Procedures. The questionnaire was mailed to the operators of the 390 nursing homes in the State of Oklahoma. The survey questionnaire is found in Appendix I. The response rate was 27%, but not all answered every question.

SIZE OF THE NURSING HOME FACILITY

Of the 105 nursing home facility operators responding, 26% (N=27) had 0-50 beds, 50% (N=53) had 51-100 beds, 17% (18) had 101-150 beds, 4% (N=4) had 151-200 beds and 3% (N=3) had more than 200 beds as shown in TABLE III and Figure 2. About 20% of the facilities had over 100 but less than 150 beds.

TYPE OF FOOD SERVICE

Of the 102 operators who responded to this question, 94% (N=94) said they prepared food in a central kitchen, only 2% (N=2) received food from satellite service, and 4% (N=4) had a combination of both as shown in TABLE IV and Figure 3. This indicates

that the majority of the facilities favor a central kitchen. Although many institutions, such as the public schools, have adopted a satellite food service system, from this survey we can infer that the Oklahoma nursing home facilities have not followed that trend. This might be because they are individually owned separate homes and there is no reason for a satellite system.

TABLE III

SIZE OF THE NURSING HOME FACILITY

Number of beds	Frequency	Percentage
0 - 50	27	26
51 - 100	53	50
101 - 150	18	17
151 - 200	4	4
More than 200	3	3
Total	105	100

Figure 2.

SIZE OF THE NURSING HOME FACILITY

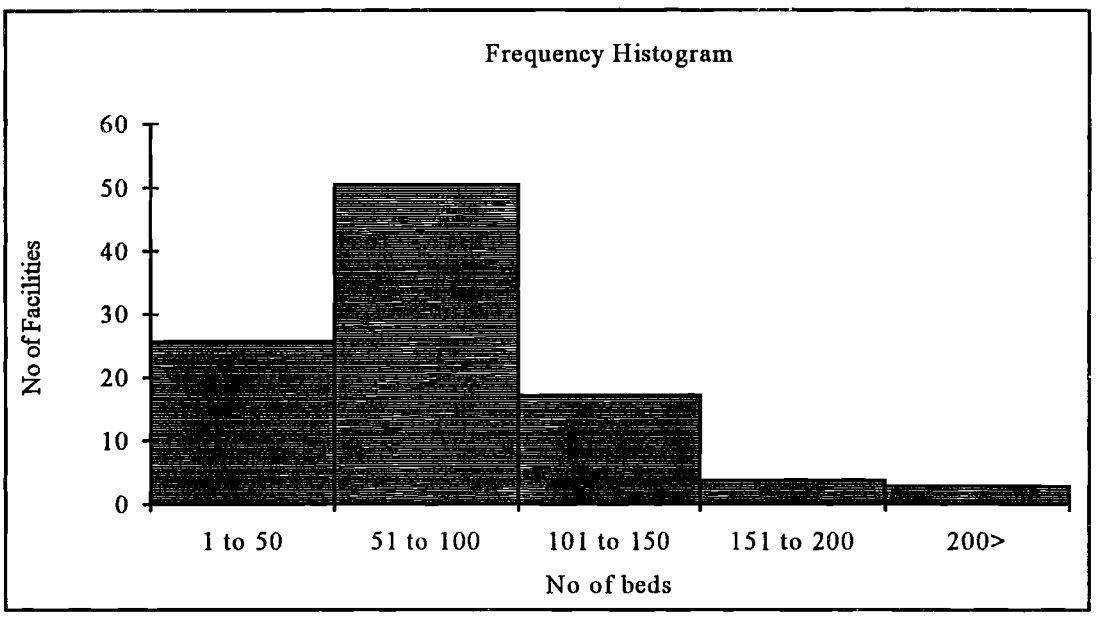
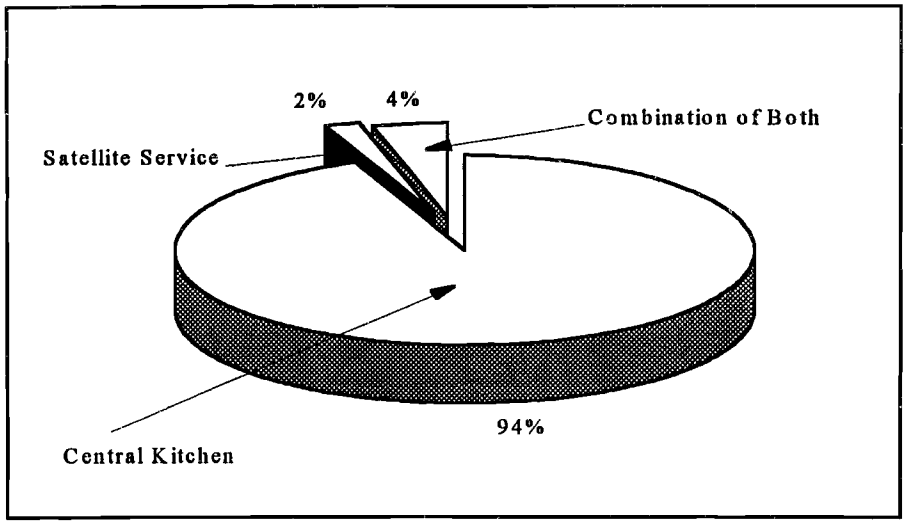


TABLE IV

TYPE OF FOOD SERVICE

Type of Food Service	Frequency	Percentage
Central Kitchen	96	94
Satellite service	2	2
Combination of both	4	4
Total	102	100

Figure 3. Type of Food Service



FREQUENCY OF PASTA IN MENU

Only 98% of the operators responded to the question. Of them 23% (N=24) had pasta once a week, 48% (N=50) served pasta twice a week, 20% (N=21) served pasta thrice in a week, and only 3% (N=3) said they serve pasta once in 15 days. This is seen in TABLE V and Figure 4. From these figures we can conclude that over 70% of the respondents serve pasta two or more times weekly. This may be due to the fact that pasta can be served in a variety of ways.

PASTA PRODUCTS USED

On this question respondents were to check all options that applied. Of them, 96% (N=101) served spaghetti, 99% (N=104) served noodles, and 99% (104) served

Figure 5. This survey indicates practically all served spaghetti, macaroni and/or noodles were served and over 95% of the respondents favor these 3 products. In addition to the flavored mixes respondents also served rotini, lasagna and ravioli. It appears that most used the basic pasta, but only 29% used convenience (pre flavored) and the exotic pasta.

TABLE V

FREQUENCY OF PASTA IN THE MENU

Frequency of pasta in the menu	Frequency	Percentage
Once	24	24
Twice	50	51
Thrice	21	22
Others	3	3
Total	98	100

TABLE VI

PASTA PRODUCTS USED

Pasta Products	Frequency	Percentage
Spaghetti	101	96
Noodles	104	99
Macaroni	104	99
Pasta in flavored mixes	21	20
Pasta in other forms	9	9

Figure 4. FREQUENCY OF PASTA IN THE MENU

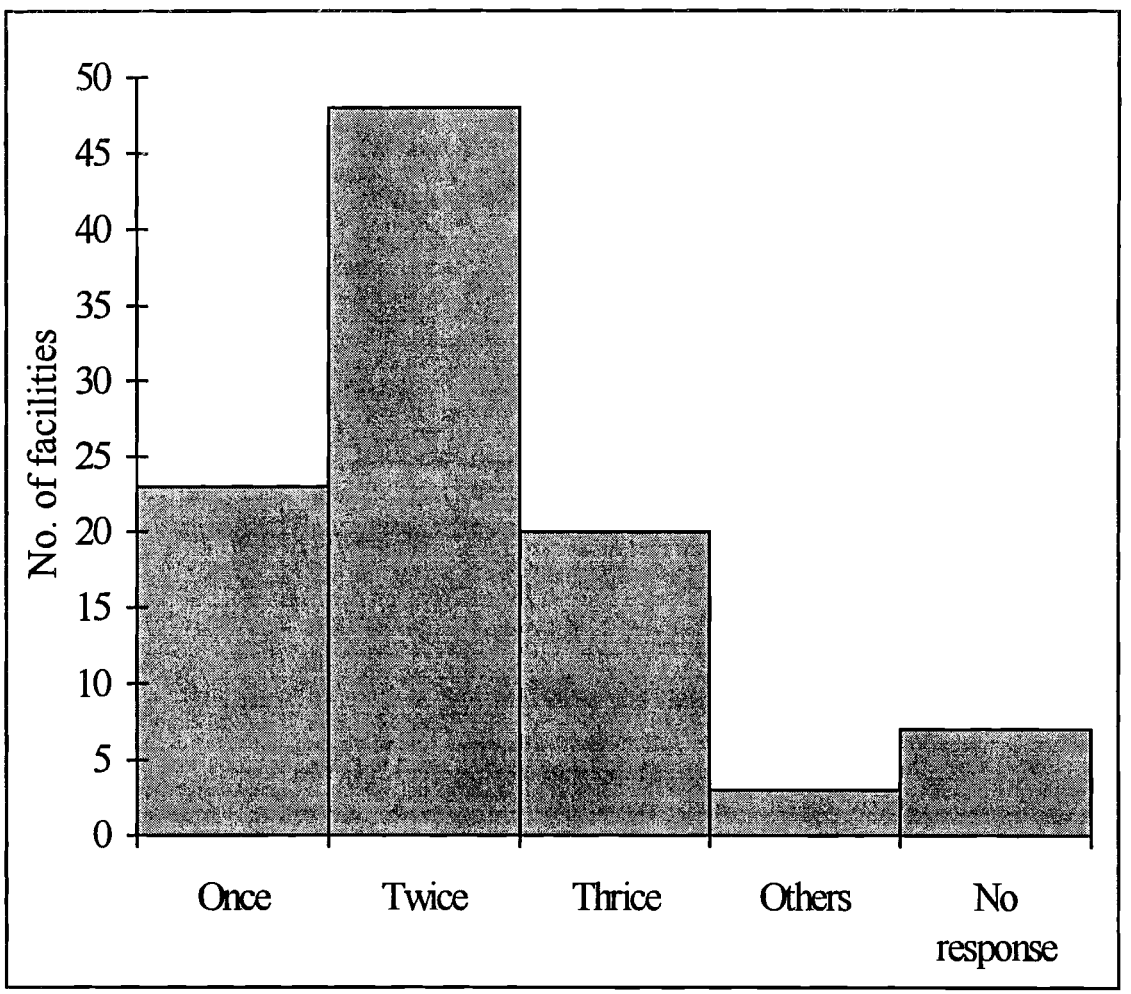
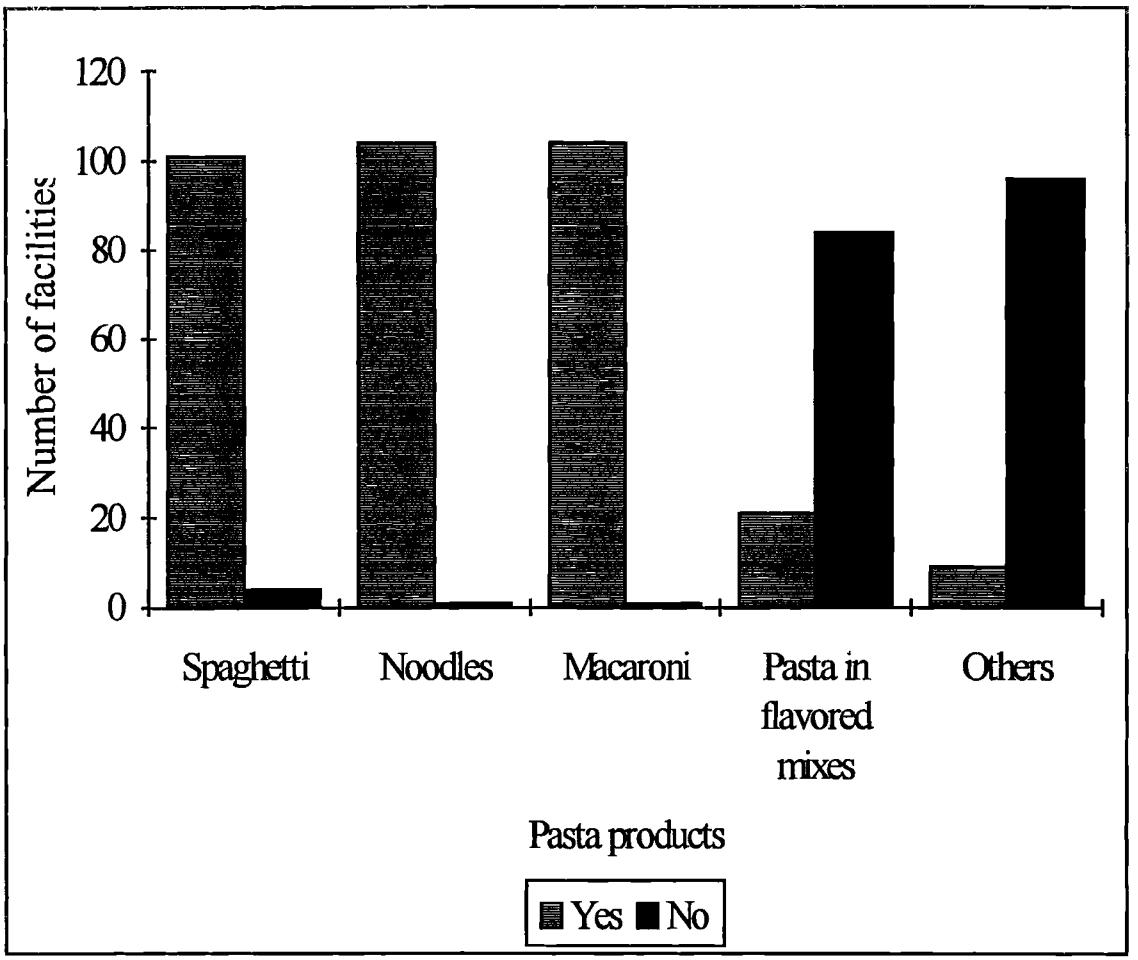


Figure 5. PASTA PRODUCTS USED



SOURCE OF PASTA

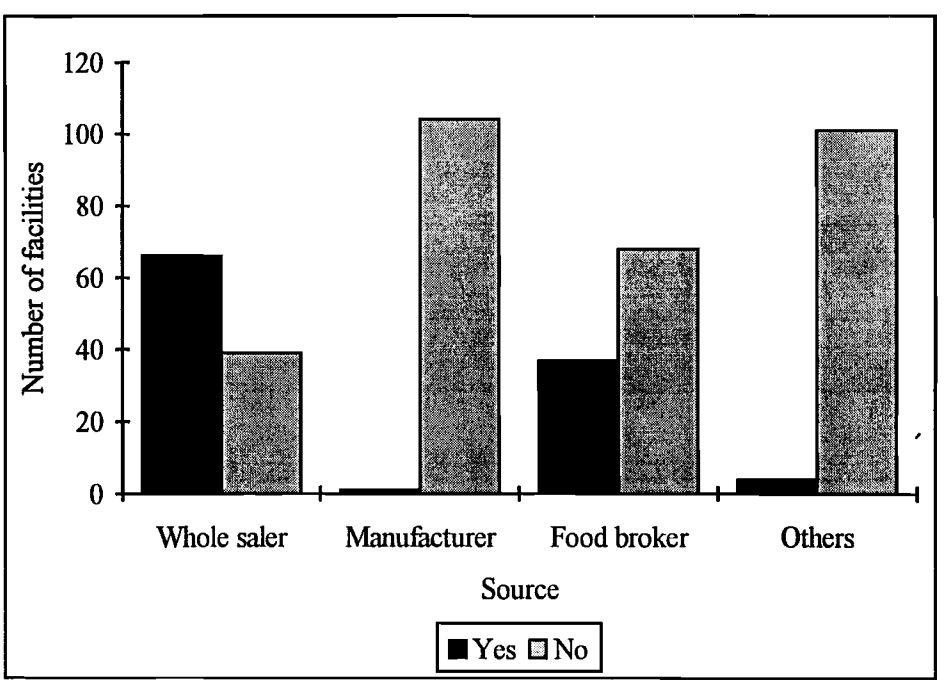
Of the 105 nursing home operators 62% (N=65) bought pasta from a wholesaler, 1% (N=1) from a manufacturer and 33% (N=35) from a food broker, and 4% (N=4) from some other source as shown in TABLE VII and Figure 6. This indicates that the majority of the respondents feel that it is to their advantage to buy directly from the wholesaler.

TABLE VII

SOURCE OF PASTA

Source of Pasta	Frequency	Percentage
Wholesaler	65	62
Manufacturer	1	1
Food broker	35	33
Others	4	4
Total	105	100

Figure 6. SOURCE OF PASTA



NURSING HOME OPERATORS INTEREST IN THE NUTRITIONALLY ENHANCED PASTA

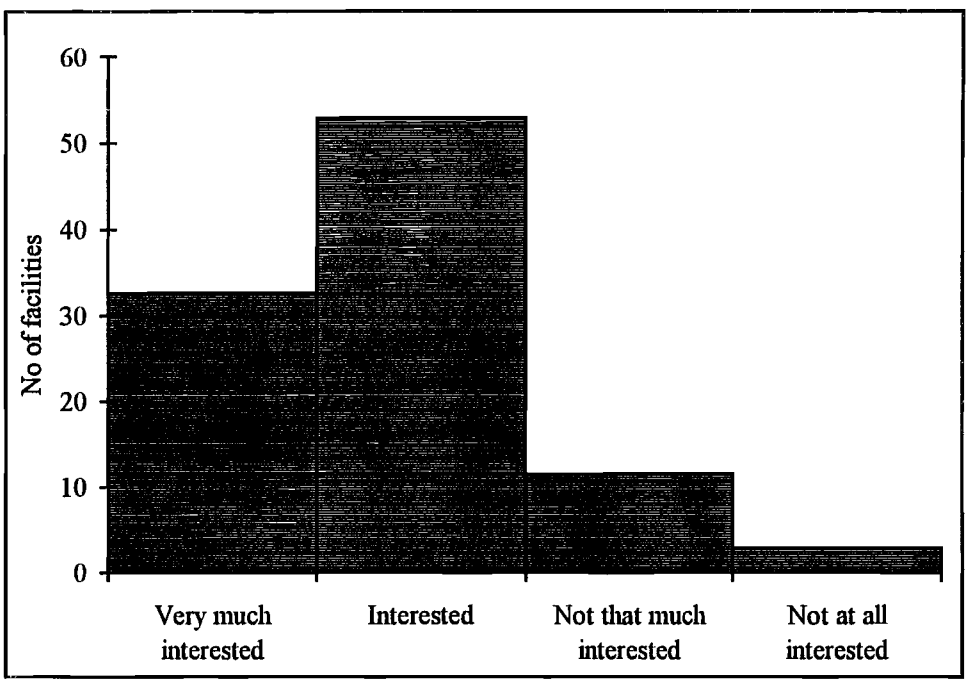
Of the nursing home operators 33% (N=34) said they were very much interested in the nutritionally enhanced pasta, 53% (N=55) said they were interested and only 15% (N=15) were not interested in the pasta as shown in TABLE VIII and Figure 7. This survey confirms our belief that the majority of the nursing home facilities are interested in the nutritionally enhanced pasta and in the nutritional status of their clients. One operator did not respond to this question.

TABLE VIII

NURSING HOME OPERATORS INTEREST IN THE NUTRITIONALLY ENHANCED PASTA

Interest	Frequency	Percentage
Very much interested	34	32
Interested	55	53
Not that much interested	12	12
Not at all interested	3	3
Total	104	100

Figure 7. NURSING HOME OPERATORS INTEREST IN THE NUTRITIONALLY ENHANCED PASTA



NUMBER OF CLIENTS RECEIVING A PROTEIN SUPPLEMENT

Virtually all of the nursing home operators, i.e., 97% (N=102) give protein supplements to some of their clients. Only three responded that they give no protein supplements to any of their clients. Of those giving supplements, 2% (N=2) gave protein supplements to all their clients, 7% (N=7) to almost all , 51% (N=54) to one-fourth, 1% (N=1) to half and 22% (N=23) gave protein containing supplements to three-fourth of their clients and three did not respond to this part of the questionnaire.. Only 11% (N=12) gave protein supplements to less than one-fourth of their clients. Data is shown in

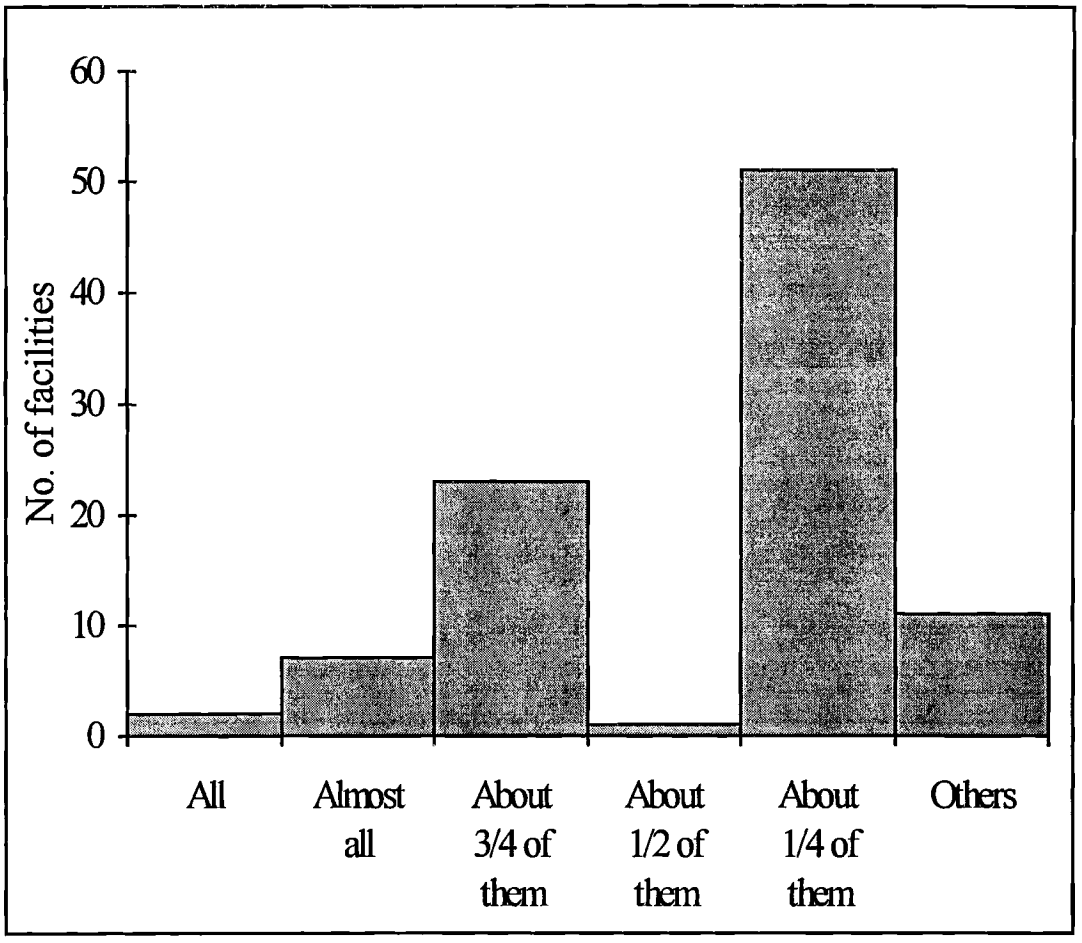
TABLE IX and Figure 8. Although almost all of the home operators provided supplemental protein, the survey responses indicate that these supplements may go to only 25% of the clients. Perhaps the perception is that the food provided is adequate in proteins for most of their clients so extra supplements are not needed.

TABLE IX

NUMBER OF CLIENTS RECEIVING A PROTEIN SUPPLEMENT

Number of clients	Frequency	Percentage
All	2	2
Almost all	7	7
About 3/4 of them	23	22
About 1/2 of them	1	1
About 1/4 of them	54	54
Less than 1/4	12	11
Total	99	100

Figure 8. NUMBER OF CLIENTS RECEIVING A PROTEIN SUPPLEMENT



TYPE OF PROTEIN SUPPLEMENTS

Of the nursing home operators responding, 55 use canned protein supplements and 61 used powdered protein supplements. Only 18 of them used other types of protein supplements such as instant breakfast, milk shake, protein malts, and milk. One operator did not respond to this question.

TYPE OF CALCIUM SUPPLEMENTATION

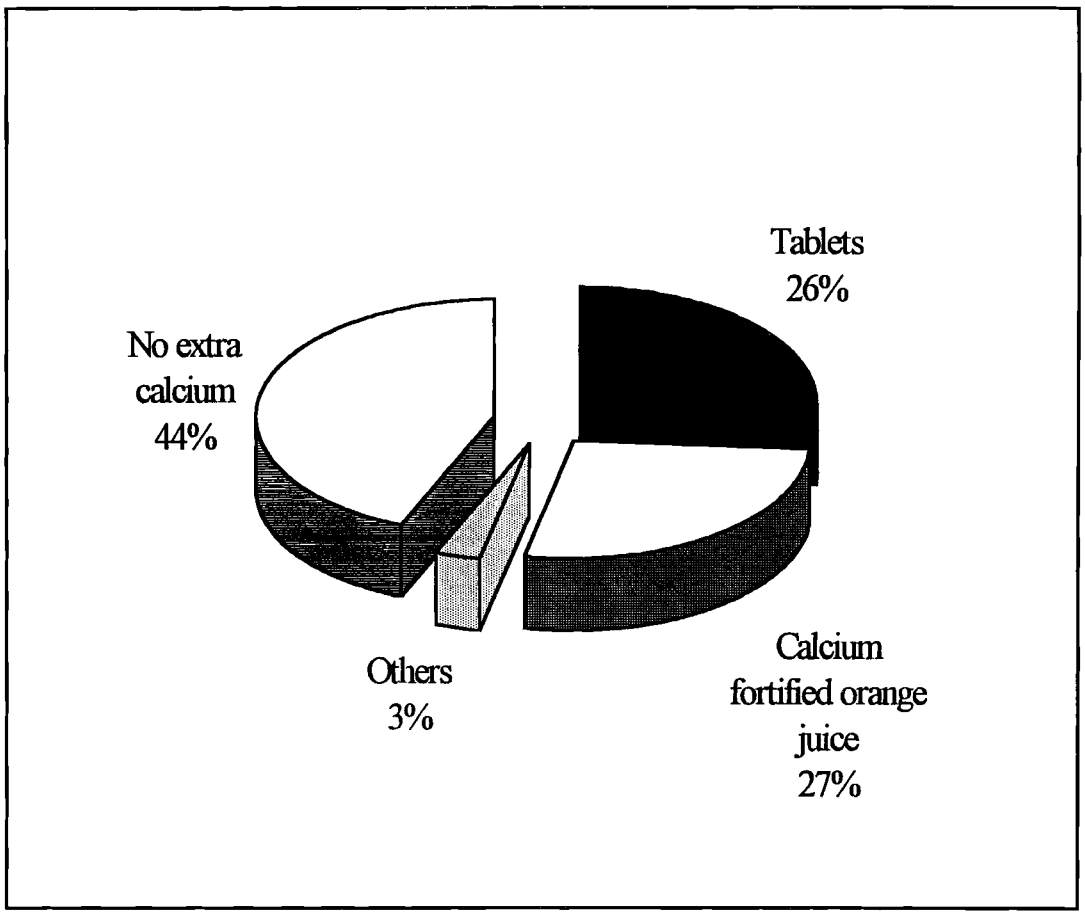
Of the 99 operators who answered this question, 25% (N=26) gave extra calcium in the form of tablets, 26% (N=27) as calcium fortified orange juice, and 3% (N=3) in other forms such as milk. As many as 41% (N=43) of the nursing home did not give any extra calcium. This can be seen in TABLE X and Figure 9. These figures indicate that less than half of the surveyed nursing homes facilities provide their clients with extra calcium.

TABLE X

TYPE OF CALCIUM SUPPLEMENTATION

Type of extra calcium	Frequency	Percentage
Tablets	26	26
Calcium fortified orange juice	27	27
Others	3	4
No extra calcium	43	43
Total	99	100

Figure 9. TYPE OF CALCIUM SUPPLEMENTATION



CLIENTS RESPONSE TOWARDS SUPPLEMENTS

Of the 102 nursing home operators responding, 67% (N=70) said that their clients tire of nutrient supplements, 22% (N=23) said their clients do not tire of nutrient supplements, and 9% (N=9) said they do not know whether their clients get tired of nutrient supplement or not. Perhaps their clients would be more receptive to supplements longer if the additional nutrients were in a good tasting form with more variety.

WILLINGNESS TO PAY FOR THE NUTRITIONALLY ENHANCED PASTA

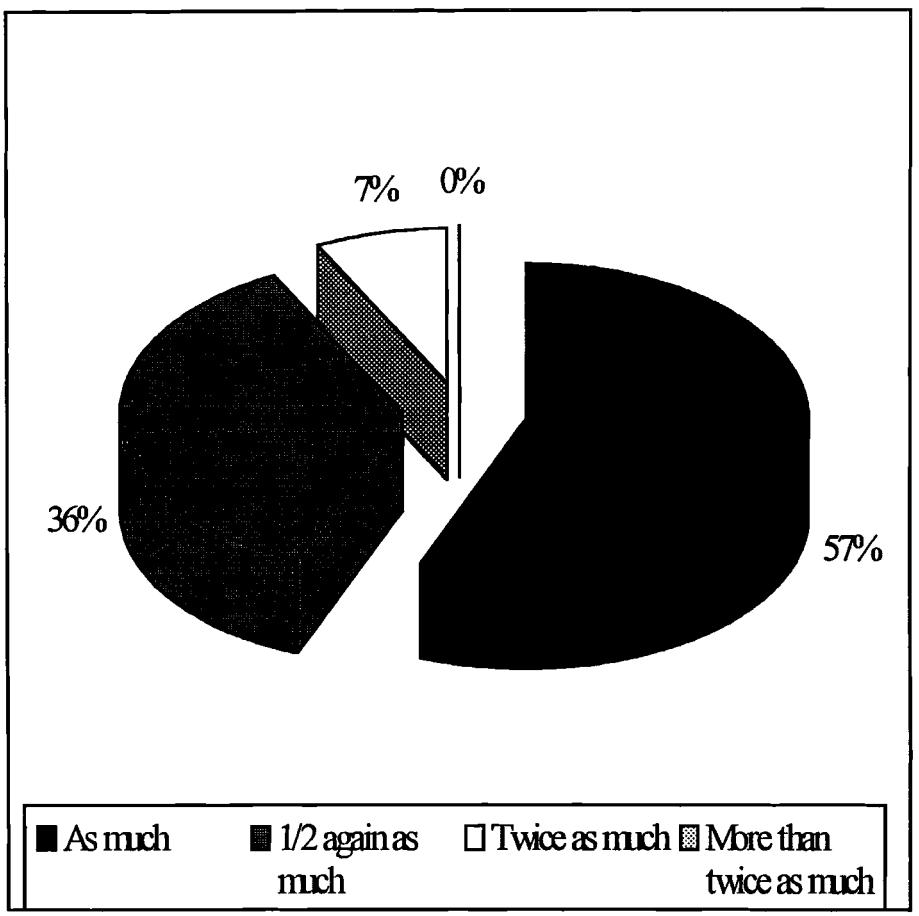
Of the 96 nursing home operators who responded 56% (N=54) were willing to pay as much they are paying currently for their pasta, but no more than that; 36% (N=35) were willing to pay half again as much they are paying now, and only 7%(N=7) were willing to pay twice as much as they are paying for their current pasta. No one was willing to pay more than twice as much. This is shown in TABLE XI, and Figure 10. It appears from this that cost will be a major influence on decisions to purchase the pasta.

TABLE XI

WILLINGNESS TO PAY FOR THE NUTRITIONALLY ENHANCED PASTA

Willing to pay	Frequency	Percentage
As much	54	56
Half again as much	35	36
Twice as much	7	7
More than twice as much	0	0
Total	96	100

Figure 10. WILLINGNESS TO PAY FOR THE NUTRITIONALLY ENHANCED PASTA



WILLINGNESS TO SERVE THE NUTRITIONALLY ENHANCED PASTA

Of the 101 nursing home operators who responded, 46% (N=46) are very willing to serve the nutritionally enhanced pasta. 17% (N=17) said they are moderately willing to serve the nutritionally enhanced pasta and 36% (N=36) of them said they are somewhat

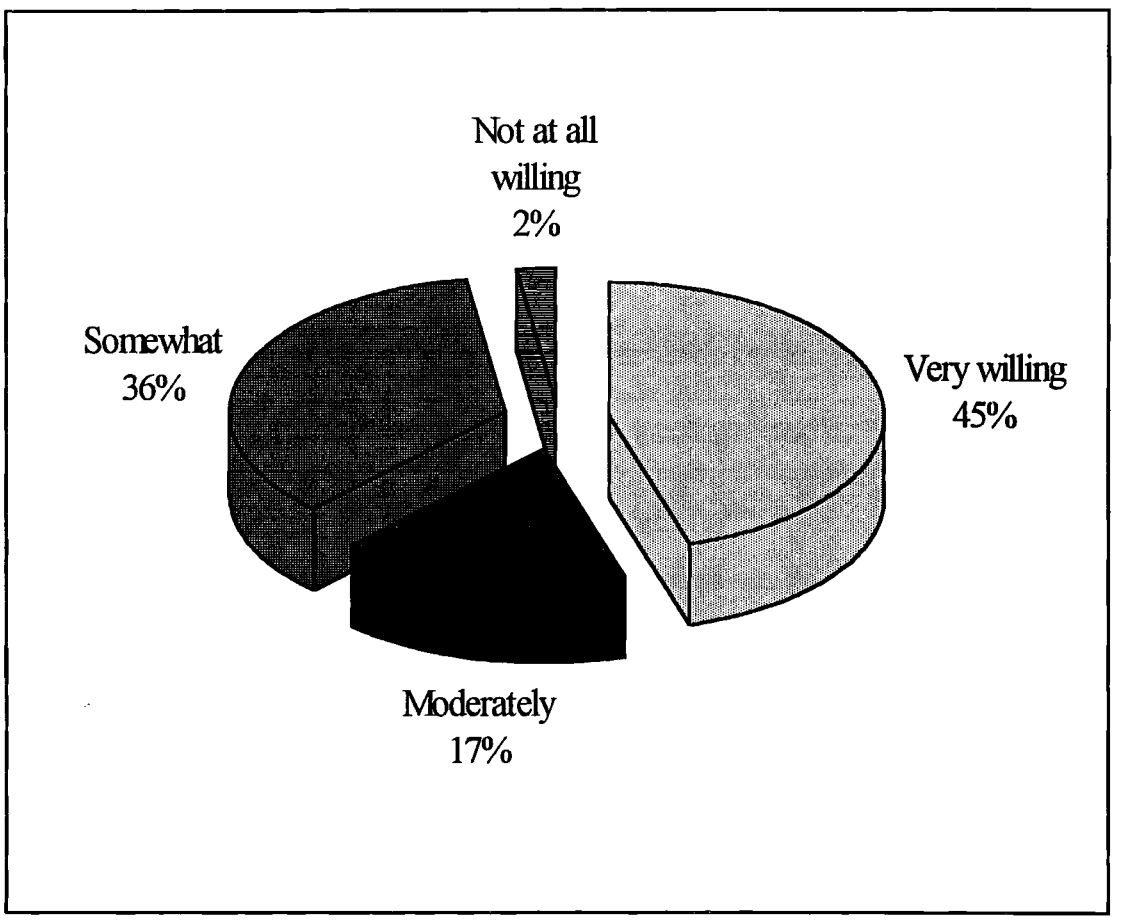
to serve the nutritionally enhanced pasta. This is shown in TABLE XII and Figure 11. No one was willing to pay more than twice as much as they are paying now. This indicates that there is a market for the nutritionally enhanced pasta if the price of the product is either the same or not too much more than the currently used pasta. However, since the majority of the respondents were willing to serve the nutritionally enhanced pasta, it appears that a market exists for this product.

TABLE XII

WILLINGNESS TO SERVE THE NUTRITIONALLY ENHANCED PASTA

Willingness to serve	Frequency	Percentage
Very willing	46	45
Moderately willing	17	17
Somewhat willing	36	36
Not at all willing	2	2
Total	101	100

Figure 11. WILLINGNESS TO SERVE THE NUTRITIONALLY ENHANCED PASTA



CHAPTER V

SUMMARY AND CONCLUSION

The purpose of this study was to determine the perceived need for the nutritionally enhanced pasta by the nursing home operators in the state of Oklahoma. For this survey 390 nursing home operators were sent the survey questionnaire. Of those, 105 responded.

About three-fourth of the responding nursing homes had 100 or fewer beds. This is reflective of the predominant size range of non-responding Oklahoma nursing homes as well. Of the responding nursing homes, 94% prepared food for their clients from a central kitchen.

Virtually all of the nursing homes who responded use pasta products : 96% served spaghetti, 99% served noodles, 20% served macaroni, and 9% served pasta in flavored mixes; 24% of them had pasta in their menu once a week; 51% of them had pasta twice a week; and 21% of them had pasta in their menu thrice a week. It seems pasta is a popular food in the nursing homes.

By far the largest number (62%) of the nursing homes surveyed bought their pasta directly from a wholesaler, although brokers did account for 35% of sales. Almost 99% of the nursing homes surveyed are providing a protein supplement to at least some of their clients, but in most cases supplementation goes only to 25% of them. Only 2% of the homes provided protein supplements to all their clients, 7% gave protein supplements to

almost all, 54% provided protein supplements to about one-fourth of their clients, 23% of them gave protein supplements to three-fourths of their clients, and 12% of them provided protein supplements to less than three-fourths of their clients. Among the responding nursing homes, 26% gave extra calcium in the form of tablets, 27% in the form of calcium fortified orange juice and 3% of them provided extra calcium in other forms such as milk. However 43% of them did not provide any extra calcium.

The respondents were asked how much they were willing to pay for the nutrient enhanced pasta as compared to the pasta they currently use. Of these, 56% were willing to pay as much as they are now paying, 36% were willing to pay half again as much, and 7% were willing to pay twice as much. No one was willing to pay more than twice as much. This implies that the product should be priced at less than twice the price of the currently used pasta for a good marketability.

About 46% of the nursing home operators were very willing to serve the nutritionally enhanced pasta to their customers, 17% of them were moderately willing to serve, and 36% of them were somewhat willing to serve the pasta. Only 2% of the nursing home operators were not at all willing to serve the nutritionally enhanced pasta. Since all but only 2% of the respondents expressed a willingness to serve the pasta, this implies a large potential market if the product is not too expensive. Nearly 86% of the responding nursing home operators were interested in the nutritionally enhanced pasta whereas only 14% of them gave a negative response. This also indicates a potential market for the product if the price is right. But these figures reflect the opinion of less

CONCLUSION

Although the responding operators expressed an active interest in the pasta, price will be a major factor influencing their decisions to buy and the success of the nutritionally enhanced pasta.

SUGGESTIONS FOR FURTHER STUDY

1. Cost analysis of the nutritionally enhanced pasta should be done to determine if it can be manufactured and sold for a price acceptable to the target market.
2. This survey was done only in the State of Oklahoma. The marketing feasibility of the nutritionally enhanced pasta outside the State of Oklahoma should be determined.
3. This survey was aimed at the nursing home facilities in the State of Oklahoma. Other target groups, such as school lunch programs, can be taken into consideration and those target groups surveyed.

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APPENDICES

APPENDIX A

SURVEY FORM

SURVEY FORM

Directions : Please read the questions carefully and check the appropriate blank. If any question does not pertain to you, just skip it. We tried to make the questionnaire as clear as possible, but if you have any questions please call us at (405) 744 5043.

1. What is the average number of clients in your facility?
   - ☐ 1 - 50 clients
   - ☐ 51 - 100 clients
   - ☐ 101 - 150 clients
   - ☐ 151 - 200 clients
   - ☐ More than 200

2. What type of food service do you have?
   - ☐ Central kitchen
   - ☐ Satellite service
   - ☐ A combination of both central kitchen and satellite service

3. In your estimation, what percentage of your clients are in each of the following categories?
   - _____% are in good nutritional health
   - _____% are in fair nutritional health
   - _____% are in poor nutritional health (at risk)

4. Which pasta products do you use in your facility? **Please check all that apply.**
   - ☐ Spaghetti
   - ☐ Macaroni
   - ☐ Noodles
   - ☐ Pasta in flavored mixes (Rice a Roni for example)
   - ☐ Others, please specify _____

5. How frequently do you serve pasta?
   - ☐ Once a week
   - ☐ Twice a week
   - ☐ Three times a week
   - ☐ Others, please specify _____

6. At present where do you buy pasta? **Please check all that apply.**
   - ☐ Wholesaler
   - ☐ Manufacturer
   - ☐ Food broker
   - ☐ Others, please specify _____

7. How interested are you in a nutritionally fortified pasta such as the one described in the accompanying letter?
   - ☐ Very much interested
   - ☐ Interested
   - ☐ Not that much interested
   - ☐ Not at all interested

8. If you purchased a fortified food such as our pasta, would you serve the fortified pasta to all your clients or only to those who are nutritionally at risk?
   ☐ All ☐ Only at risk

9. Do you give protein nutritional supplements to any of your patients?
   ☐ Yes ☐ No

10. If yes, approximately how many of your clients receive a protein nutritional supplement in addition to (or in place of) a regular meal?
   ☐ All ☐ Almost all
   ☐ About three-fourth of them ☐ About half of them
   ☐ About one-fourth of them ☐ Others, please specify
   _____

11. What type of protein containing supplements do you give to your at risk patients? **Please check all that apply.**
   ☐ We use canned supplements
   ☐ We use powdered supplements
   ☐ We use other protein supplements such as _____

12. Overall, about how many servings of those protein supplements do you use in your establishment in an average week?
   _____ servings per week

13. In addition to calcium in their meals or in a once daily vitamin/mineral tablet, do you provide some or all of your clients with extra calcium in the form of:
   ☐ Tablets ☐ Calcium fortified orange juice
   ☐ Others, please specify _____ ☐ We do not provide extra calcium

14. On a long term basis, do your clients tire of nutrient supplements?
   ☐ Yes ☐ No ☐ Don't know

15. In your opinion, are nutrients eaten as a part of food better used by the body than a commercial supplement.
   ☐ Yes ☐ No ☐ Don't know or no opinion

16. If a well accepted fortified pasta could reduce your use of nutrient supplements, how much you would consider paying for the nutritionally enhanced pasta as compared to your currently used pasta?
   ☐ As much but no more ☐ Up to half again as much
   ☐ Twice as much ☐ More than twice as much

17. Would you be willing to consider serving a nutritionally fortified pasta in your facility particularly to your nutritionally at risk clients?

☐ Very willing ☐ Moderately willing
☐ Somewhat willing ☐ Not at all willing

We have tried to keep this form short and simple. However, if there any other thoughts you would like to add, please feel free to do so. Again be assured that your response will be completely anonymous.

Other comments:

_____

_____

_____

_____

APPENDIX B

COVER LETTER

Oklahoma State University

DEPARTMENT OF NUTRITIONAL SCIENCES
COLLEGE OF HUMAN ENVIRONMENTAL SCIENCES

STILLWATER, OKLAHOMA 74078-0337
425 HUMAN ENVIRONMENTAL SCIENCES
(405)-744-5040

Dear Sir/Madam:

The department of Nutritional Sciences at Oklahoma State University has developed a nutrient dense pasta that is designed to help meet the nutritional needs of the frail elderly. Many of the elderly have increased nutrient needs but have a decreased appetite. Your input and reaction as a professional in the long term health care industry will help us to determine the economic viability of a commercially produced nutrient dense pasta. The information you provide to us on the enclosed survey can help us make that decision. Your response does not commit you or your institution in any way.

As you know from your own experience and from what studies confirm is that it is difficult for the frail elderly to meet their nutritional requirements with the limited amounts of foods they are willing to consume. This is especially true with protein and calcium. A single serving of the nutrient dense pasta developed at Oklahoma State University will furnish the amount of protein (6 grams) equal to a large, whole egg and provide as much calcium as in a glass of milk. The ingredients used in our pasta are all Generally Recognized As Safe (GRAS) by the United States Food and Drug Administration. The pasta ingredients are : Oklahoma grown flour, fresh egg and dried egg white, dried caseinate from milk protein, calcium in the form of calcium carbonate, and a small amount of torula yeast. Based on our previous research, our pasta is nutritionally effective while retaining typical pasta flavor acceptability.

Please take five minutes of your time to complete the survey and return it to us in the enclosed self addressed, postage paid envelope. You will notice that nowhere on the survey nor on the return envelope is your name or the name of your institution mentioned or asked for. This will help to assure complete anonymity for respondents. If someone else on your staff is the appropriate person to complete this survey, please pass this on to that person.

You may contact Dr. Sue Knight at (405) 744-5043 if you have questions about this survey or about our fortified pasta. This survey study has been approved by the Oklahoma State University Research Institutional Review Board. If you have any questions about your rights as research subject, please contact Ms. Jennifer Moore at the University Research Center, 001, Life Sciences East, Oklahoma State University, Stillwater, OK 74078. Be assured that your participation in this survey is voluntary and also that by completing the survey you have not waived any of your legal rights nor released the University from liability for negligence. Again, thank you for your time and input.

P. Balaji

Balaji Palaniswamy

APPENDIX C

IRB FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 06-23-94 **IRB#:** HE-94-044

Proposal Title: MARKETING FEASIBILITY OF FORTIFIED PASTA

Principal Investigator(s): Sue Knight, Balaji Palaniswamy

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: _____ Date: June 23, 1994

Chair of Institutional Review Board

VITA

Balaji Palaniswamy

Candidate for the Degree of

Master of Science

Thesis: MARKETING FEASIBILITY OF NUTRITIONALLY ENHANCED PASTA

Major Field: Nutritional Sciences

Biographical:

Personal Data : Born in Coimbatore, TamilNadu, India, on June 19,1966, the son of R. Palaniswamy and P. Velumani

Education : Graduated from Shree Baldevdas Kikani Vidhyamandir Higher Secondary School, Coimbatore, Tamil Nadu, India, in May 1985; received Bachelor of Science in Nutrition, Food Service Management and Dietetics from Bharathiar University, India in May 1988, received Master of Science in Food and Nutrition from Bharathiar University, India in May 1990. Completed the requirements for the Master of Science degree with a major in Nutritional Science at Oklahoma State University in May 1995.

Experience: Employed by Oklahoma State University, Department of Nutritional Sciences as a graduate research and teaching assistant; Oklahoma State University, Department of Nutritional Sciences.