DEVELOPMENT AND APPLICATIONS OF AN APPLE-FLAVORED PASTA

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Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1989

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
December, 1991

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APPLE-FLAVORED PASTA

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my thesis advisor, Dr. N. Sue Knight for her guidance, support, and patience. I also gratefully acknowledge the other thesis committee members, Dr. Ibrahim Wahem, for his expert advice, and Dr. Janice Williams, for her assistance in research design and statistical analyses.

Also, a special thanks to Doris Dougherty for her helpful advice and information.

Sincere appreciation is also expressed to the Oklahoma Wheat Commission, for their encouraging interest and financial support.

Finally, I extend a special thanks to Dad, Mom, Carl, James, Melissa, Roz, Mark, Jamal, Kathy, Mr. and Mrs. Delaloye, and Bonnie, for their warm encouragement, love, and friendship.

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CHAPTER I

PROPOSAL FOR RESEARCH

Introduction

Today, more than ever, Americans are aware of the important link between diet and health. The evolution of the appeal of high nutritional value has heavily influenced the food industry's marketing strategies. Television commercials now routinely bombard the airwaves with "low in cholesterol," "low in saturated fat," "low in salt," "low in calories," "high in fiber," "high in oat bran," and "rich in beta-carotene;" foods that are of nutritional importance to their customers. Thus, there is a strong movement toward healthy eating.

However, this is not uniform movement. Rather, two steps forward and one step backward realistically depicts this scenario. For example, while the sales of oat bran products have skyrocketed in the 1980's, so have butter-rich gourmet cinnamon rolls and chocolate chip cookies (Brody, 1982). Keeping this in mind, Americans want both healthy eating, but taste is still and will probably always be the determining factor in the consumers' food selections.

Fortunately, pasta is a food product which can satisfy demands. First of all, it offers quality nutritional content. It contains complex carbohydrates, B- vitamins, iron, and it is extremely low in fat content. Secondly, pasta offers an appealing, mild, tender flavor that is enhanced when combined with seasoned meats, cheeses, sauces, and/or herbs.

Up until now, however, pasta was always served as either an appetizer, a salad, a side dish, or as an entree with primarily tangy flavors such as tomato, meat, or cheese sauce. Surprisingly, the menu never presents pasta as a dessert dish. Yet pasta's broad versatility should allow it to combine and compliment sweets and spices as well. And, by incorporating pasta into a dessert, the fat content could be greatly reduced. This is illustrated by the fact that, for example, 28.35 grams of piecrust contain ten grams of fat while 28.35 grams of cooked pasta contain about 0.2 grams of fat (Pennington and Church, 1985). In other words, piecrust is 50 times higher in fat than is pasta on a weight basis!

Furthermore, not only would a dessert pasta be beneficial to a healthy diet, but Oklahoma's economy could likewise benefit. By creating new wheat-based dessert products, Oklahoma's enormous hard red winter wheat crop could gain stronger demand. Pasta is normally prepared with durum wheat, a crop grown in the north-central part of the United States. However, Oklahoma State University's Col-

lege of Home Economics, in cooperation with the Oklahoma Wheat Commission, has developed a highly acceptable pasta product using Oklahoma hard red winter wheat.

Thus, the purpose of this research is to develop an apple-flavored pasta dough with the same texture characteristics of traditional pasta, and apply this dough into a consumer-acceptable, low-fat dessert.

Hypotheses and Objectives

Hypothesis I: There will be no difference in texture when concentrated apple juice is incorporated into a conventional pasta dough.

Hypothesis II: A dessert which incorporates the apple-flavored pasta dough will be high in fat (greater than 30% of calories from fat).

Hypothesis III: A dessert incorporating the apple-flavored pasta dough will be judged "not acceptable" by sensory evaluation panelists.

This research will consist of four steps:

1. The first step is the development of an apple-flavored pasta dough. This dough will be an adaptation of a hard red winter wheat pasta dough developed by Oklahoma State University (OSU) and the Oklahoma Wheat Commission.

2. The second step is to objectively analyze the sweetened pasta dough for texture using the Food Technology System Model PC T-1200 equipped with Model CA-1 single blade shear cell. A 2 X 2 factorial Analysis of Variance

(ANOVA) design will be implemented for analysis of two variables each having two conditions:

A. Conventional pasta dough boiled in water
B. Conventional pasta dough boiled in apple juice
C. Apple-flavored pasta dough boiled in water
D. Apple-flavored pasta dough boiled in apple juice.

3. The third step will be to make a dessert application with the flavored dough, apple ravioli, and to perform sensory evaluation with this apple-flavored pasta dessert. The design will involve a consumer acceptance test using 50 untrained panelists. Means, standard deviations, and correlations of the sensory qualities of sweetness, apple flavor, texture, and overall quality will be calculated on panelists' ratings.

4. The fourth step will be to compare certain nutritional aspects of the apple pasta with those of piecrust.

Definition of Terms

The following are the definition of terms used in this study:

Pasta. A usually dried food product made from a paste of flour and water (Morris, Ed., 1973).

Extrusion. The process of shaping a dough by pressing through a die (Morris, Ed., 1973).

Extraction Rate. The extent of recovery from milling flour from 100 lbs of wheat (Campbell et al., 1979).

Gluten. The proteins in flour which interact during mixing to provide a framework for the cooked product (Freeland-Graves and Peckham, 1987).

Gliadin. A low-molecular weight fraction of gluten responsible for dough cohesiveness (Wahem, 1990).

Glutenin. A high-molecular weight fraction of gluten responsible for dough elasticity (Campbell et al., 1979).

Ravioli. Small casings of pasta with various fillings (Morris, Ed. 1973).

Middlings. Coarsely ground wheat mixed with bran (Morris, Ed., 1973).

Semolina. Purified middlings of durum wheat that have been ground to pass through a No. 20 U.S. sieve (Campbell et al., 1979).

Farina. Middlings of ground wheat, similar in size to semolina (Morris, Ed., 1973).

Endosperm. Inner portion of wheat kernel without the germ (embryo). It comprises the largest portion of the kernel (83%) and is a storage place for starch grains. The milled endosperm is used for flour (Campbell et al., 1979).

Format of Thesis

The experiment described in Chapter III was organized and prepared as an individual manuscript for publication in the Journal of Food Science. The experiment was written

according to the Style Guide for Research Papers, Institute of Food Technologists, and the Journal of Food Science.

CHAPTER II

REVIEW OF LITERATURE

Pasta History

Today, pasta is an extremely popular food. Yet most people do not realize that pasta-making is one of the oldest forms of food processing. Pasta was a staple food as far back as 1700 B.C. in China's Shang Dynasty (Del Conte, 1976). Most people believe the Italians originated pasta. Actually, the Chinese, Arabians, and Greeks had long before been savoring pasta, and the recipe did not reach Italy until 1400 A.D. However, the Italians were able to develop pasta's huge popularity because they, at that time, possessed the most highly developed culinary skills (Del Conte, 1976). Obviously, pasta must be an appealing item since it is still consumed some 3700 years later, although other food choices are readily available.

A review of current practices concerning pasta includes a look at nutritional values, examination of the raw materials that go into pasta, and how pastas are produced. Also, the concept of pasta as a dessert will be explored along with subjective and objective tests for such a product.

Nutritional Value for Pasta

Pasta remains popular today because the mild flavor is appealing to people worldwide, despite vast cultural differences, and also because pasta is perceived as a healthy food for the diet-conscious. In fact, pasta has many nutritional benefits. It is a low-fat, high carbohydrate food, and it contains many vitamins and minerals as well (Pennington and Church, 1985). Table I shows the nutritional content for 100g of uncooked egg noodle on a dry weight basis as reported by Lintas et al. (1988).

Unfortunately, these nutritional components suffer some degradation during cooking. For example, as much as 60% of the potassium may be lost, while the losses for iron, copper, phosphorus, zinc, calcium, manganese, and magnesium were less severe at 20%. "Two servings (340g) of the cooked products provided 9.8%, 10.5%, 15.6%, 16.1%, 24.3%, and 28.0% of the US-RDA for Zn, Mg, Cu, P, Fe, Mn, respectively" (Ranhotra et al., 1982). Riboflavin losses are about 38% in the cooking water and as much as a 64% when exposed to light (Furuya and Warthesen, 1984). Niacin's cooking loss ranged from 38% to 50% while thiamin's cooking loss ranged from 42% to 54% (Ranhotra et al., 1983).

Flour enrichment laws reflect these cooking losses. According to paragraph 16.9 of the Food and Drug Administration Definitions and Standards for Macaroni Products, to be labeled as "Enriched Macaroni," each 454g of pasta

TABLE I

NUTRITIONAL VALUE OF UNCOOKED PASTA
(PER 100g DRY WT)

Nutrient	Enriched Noodle Product Amounts (mg)	Range For Recommended Dietary Allowances (mg)
Thiamine	1.08	0.3-1.5
Niacin	7.94	6.0-19.0
Riboflavin	0.49	0.4-1.7
Vitamin B6	0.088	0.3-2.0
Folacin	16.0mcg	30.0-400.0mcg
Vitamin E	trace	3.0-10.0
Pantothenic acid	---	4.0-7.0
Biotin	---mcg	100.0-200.0mcg
Iron	4.91	10.0-18.0
Calcium	32.0	360.0-1,200.0
Magnesium	71.0	50.0-300.0
Phosphorus	215.0	240.0-1,200.0
Potassium	191.0	1,875.0-5,625.0
Sodium	21.0	1,100.0-3,300.0
Zinc	1.76	3.0-15.0
Copper	0.260	2.0-3.0
Manganese	0.690	2.5-5.0
Selenium	85.0mcg	50.0-200.0mcg

(Lintas et al., 1988)

"must contain not less than 4 mg and not more than 5 mg of thiamin, not less than 1.7 mg and not more than 2.2 mg riboflavin, not less than 27 mg and not more than 34 mg niacin or niacinamide, and not less than 13 mg and not more than 16.5 mg of iron" (Walsh and Gilles, 1977).

In addition to the enrichment of vitamins and minerals, pasta improves any diet because it is a high-carbohy-

drate, very low-fat product. Pennington and Church (1985) give the nutritional content of 146g cooked, enriched spaghetti:

TABLE II

NUTRITION CONTENT OF COOKED PASTA (146g)

Kcalories	216
Protein (incomplete*)	7 g
Fat	0.7 g
Carbohydrate	44 g
Thiamin	0.26 mg
Riboflavin	0.15 mg
Niacin	2.0 mg
Sodium	1 mg
Potassium	115 mg
Calcium	16 mg
Phosphorus	95 mg
Magnesium	29 mg
Iron	1.6 mg

(Lintas et al., 1988; Pennington and Church, 1985)

Pasta's mild flavor allows its incorporation into a vast number of foods ranging from salads, to side dishes, to a huge variety of main courses such as spaghetti with meatballs, lasagna, ravioli, and stuffed manicotti (Del Conte, 1976). Surprisingly, pasta is only rarely used in desserts. A search through many cookbooks located only two pasta-containing desserts, pasta dough with grated orange peel and pasta dough with cocoa (Del Conte, 1976; Harris,

1984). In the quest for low-fat desserts, pasta has been overlooked. While piecrust is a tasty "container" for cream and fruit fillings, piecrust is 50 times higher in fat than pasta (Pennington and Church, 1985).

Composition of Pasta

Durum Wheat in Pasta Manufacturing

Normally, pasta is made with semolina of durum wheat, Triticum durum L, which gives pasta its bright yellow-amber color, and its firm "al dente" bite (Walsh and Gilles, 1977). This is because of its high carotenoid and protein contents, respectively. Naturally, cultivars of durum wheat grown in different parts of the world vary in characteristics. For example, U.S. durum contains a higher protein content than Italian durum (13% vs. 10.6%), and the colors in the U.S. durum are more desirable than in the Italian durum (Shuey et al., 1977).

Protein in wheat plays a vital role in pasta's texture and its cooking qualities. There is a positive relationship between the soluble gluten content of the flour, the flour's protein fraction, and the quality of cooked pasta (Dexter and Matsuo, 1980). Durum wheat's high content of gluten (10-14%) influences pasta's texture. This high protein content enables the flour to form a cohesive, elastic, extensible, and sheetable dough which is necessary for the noodles to withstand boiling without breaking down the texture (Hoseney, 1986). However, other studies indicate that

when protein is supplemented to increase dough strength, the cooking quality of pasta is decreased (Haber et al., 1978). The proteins also enhance the color of the natural carotenoids present (i.e., xanthophyll) in the flour which also lends to pasta's quality (Dick and Matsuo, 1988). The evaluation for semolina color can be performed either visually, by reflectance colorimeter (Johnson et al., 1980), or by the American Association of Cereal Chemists' water-saturated butanol (WSB) method of pigment extraction (AACC, 1961).

There are standards of identity for making pasta products in the U.S. that are made with durum wheat. "Semolina is defined as the purified middlings of durum wheat which have been ground so that all of the product shall pass through a No. 20 U.S. sieve and not more than 3% shall pass through a No. 100 U.S. sieve. Durum granular is defined as the purified middlings of durum wheat which shall pass through a No. 20 U.S. sieve and not more than 20% shall pass through a No. 100 U.S. sieve. Durum flour is the purified endosperm of durum which is ground fine enough to pass through a No. 100 sieve" (Walsh and Gilles, 1977). Of course, a wide variety of combinations can be obtained by blending these in order to obtain a desired quality. This quality of pasta is rated on two primary factors: the yellow index and the cooking value of pasta (Palvolgyi et al., 1982).

Hard Red Winter Wheat (HRWW) in Pasta Manufacturing and Comparisons between Durum and HRWW

Normally, hard red winter wheat, Triticum aestivum L, is used in bread making because its high protein content (13%) is necessary for optimum CO_2 retention (Campbell et al., 1979). Durum wheat, Triticum durum L, has an equally high protein content, but this protein composition behaves more like soft wheat which means durum gluten is weaker than hard wheat gluten (Hoseney, 1986). Wheat gluten contains two main types of proteins, glutenin and gliadin. In comparison to bread wheat, the proportion of glutenins in the gluten portion of durum is very high, and the glutenins are responsible for the pasta dough's elastic and cohesive characteristics. It has been noted that common wheat and durum wheat in which the gliadins aggregated during heating displayed better cooking qualities in bread and pasta, respectively (JeanJean et al., 1980). Also certain gliadins, together with low molecular weight glutenins (12,000-60,000) are specifically designated as giving pasta dough firmness and elasticity (Feillet et al., 1976). During the extrusion of pasta dough, the gliadin content was reported to increase due to the breakage of the disulfide (S = S) bond in the glutenin molecules (Feillet et al., 1976). The specific gliadins that may be important in predicting pasta quality in durum wheats are gliadin bands 42 (indicative of weak gluten) and 45 (indicative of

strong gluten) as found by using polyacrylamide gel electrophoresis (PAGE) (Kushnir et al., 1983; Lintas et al., 1988).

Furthermore, the cost of durum wheat is very high in comparison to common wheat due to durum's relatively low extraction rate (between 48-65%) while common wheat's extraction rate is between 70-75% (Wahem, 1990).

Benefits of Using HRWW in Pasta Manufacturing

Fortunately, common wheat can and is being used for pasta products. Studies performed at Kansas State University show that while durum wheat pasta has the nice yellow-amber color and is generally more resilient and less sticky than common wheat pasta, hard wheat pasta shows good cooking quality (Dexter and Matsuo, 1978; Kim et al., 1989; Feillet et al., 1989). According to Fernandes et al., (1978) a pilot study indicated that "intermediate size granular millstreams appear to be the most promising for pasta production from bread wheat varieties" (Fernandes et al., 1978). Both Oklahoma State University and Kansas State University have developed consumer-accepted pastas using hard red winter wheat (Knight, 1989; Kim et al., 1986). Since the United States produces over 70% of the world's wheat, mostly hard wheat varieties, a greater demand needs to be developed for hard wheat products (Wahem, 1990). Another study at Kansas State University

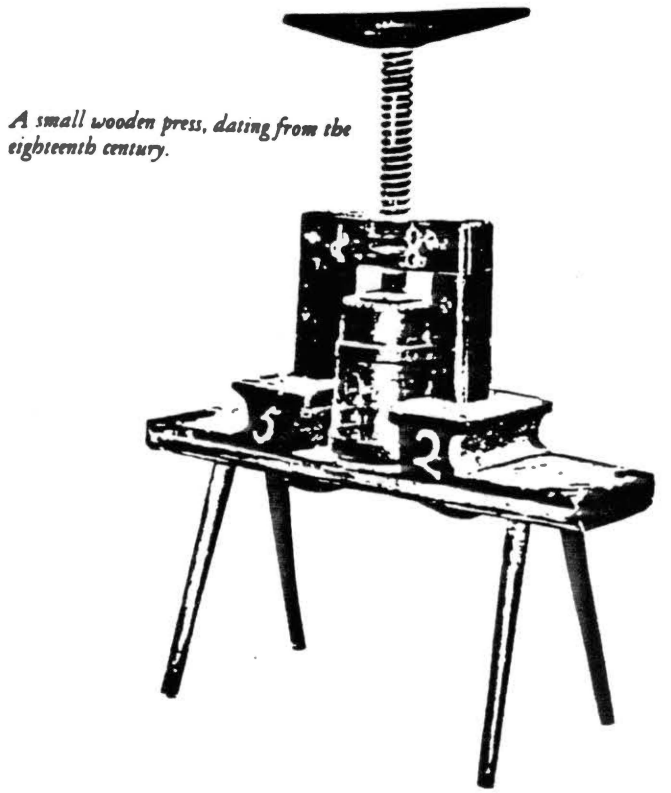
found that hard red winter wheat varieties produce a quality pasta when their flour contents of farina increased from 2.5% to 24.7% (Kim et al., 1986). However, as farina content increased, brightness (pigmentation) decreased, but when B-carotene was added at 3 ppm, a stable, close color match to durum pasta's coloring was obtained (Kim et al., 1986). Oklahoma State University's findings show that pasta made from hard wheat was just as, if not more, acceptable in the sensory evaluation than the pasta made from durum wheat (Knight, 1989). Also, manufacturing pasta made from hard wheat requires no extreme changes in procedures or equipment from manufacturing pasta from durum wheat.

Commercial Pasta Production

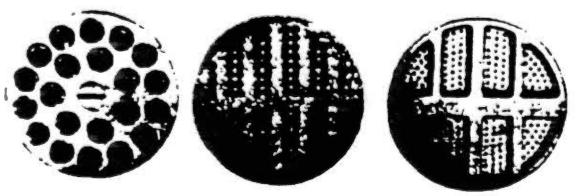
Introduction

Most commercial pasta is produced by extruding dough through shaped dies. Extrusion is one of the oldest forms of food processing, and the mechanization of pasta processing has existed since 1850 (Walsh and Gilles, 1977) (Figure 1).

The process is simple but the technology has greatly advanced. By 1900, pasta processing was fully mechanized (Del Conte, 1976). By 1935, pasta manufacturers changed from batch processors to continuous processors (Tejada, 1982). Still, the principles remain the same as when the Chinese first created pasta in 1700 B.C. (Del Conte, 1976).



A small wooden press, dating from the eighteenth century.



Three dies, dating from about 1900, for the extrusion of long pasta.

(Del Conte, 1976)

Figure 1. Historical Pasta Manufacturing Equipment

The Mixing Stage

A mixing chamber is located above the extrusion system for gravitational purposes. The mixing chamber is usually a stainless steel bin with stainless steel mixing arms or blades. The chamber can be either a single shaft or a double shaft, the double shaft being more efficient but more expensive (Tejada, 1982). The mixing chamber is where water is added to semolina to a 31% moisture level and mixed to form a relatively dry dough (Hoseney, 1986). This is where the starch and proteins are hydrated, enabling gluten development to begin, and a homogenous mixture is obtained (Antognelli, 1980). The optimum temperature of the added water is 35-40°C in order to reduce the mixing time to under 15 minutes because excessive mixing time allows the oxidation of the pigments (Antognelli, 1980).

The Vacuum Chamber

The best quality manufacturers follow mixing with vacuuming. Once the ingredients have been adequately mixed, the dough enters the vacuum chamber where 60-80% vacuum of atmospheric pressure is obtained by vacuum pump (Tejada, 1982). This is performed in order to prevent bubble and chalky color formation, and also to produce a smoother texture, an increased transparency in the finished product, and a greater specific weight. Also, vacuum prevents cracking of pasta upon cooking (Banasik, 1981; Tejada, 1982). As a vacuum is drawn, the dough volume increases

due to the dough protein's ability to absorb around 200 times its weight of water and the starch's ability to absorb about 35% its weight of water, resulting in pressure and temperature buildup (Antognelli, 1980). Vacuum would normally allow greater enzymatic activity to occur due to the more compact dough, and, hence, would result in undesirable products. However, the temperature build up is too high for the enzyme's optimal activity (Antognelli, 1980). The vacuum is maintained during extrusion.

The Extrusion

Within this vacuumed extrusion chamber, the auger (worm) kneads the dough into a homogenous mass to be extruded. The rate of the auger movement influences quality of the end product due to adequate or inadequate gluten development (Walsh and Gilles, 1977; Hoseney, 1986). The auger is housed in a grooved extrusion barrel. "The grooves help the dough to move forward and to reduce friction between the auger and the inside of the barrel," thus relieving stress on the system (Walsh and Gilles, 1977). As friction and pressure build up to between 100 and 120 Kg/cm^2, the temperature increases (Tejada, 1982). The amount of heat build-up in this process is maintained near 51°C to allow partial starch gelatinization (which enhances pasting properties) and to somewhat decrease the dough's viscosity before entering into the die system (Valle et al., 1987). However, if heat builds to 74°C, protein dena-

turing would occur, resulting in inferior cooking quality (Walsh and Gilles, 1977; Freeland-Graves and Peckham, 1987).

The Die System

Once the dough has traveled through the extrusion chamber and is forced through the die, it becomes noodles, spaghetti, macaroni, etc. depending on the shape of the die. The dies are attached to the end of the extrusion barrel with the assistance of the extrusion head or cylinder head (Tejada, 1982). Until recently, dies were made of bronze because it lent "uniform extrusion characteristics" and provided pasta with good color and cooking quality (Walsh and Gilles, 1977). However, bronze is a soft metal which wears easily, and thus, bronze dies must be replaced often. Now, however, Teflon inserts have been added, prolonging the life of the die by maintaining its shape. Also, the produced pasta has a very smooth surface due to Teflon's low friction (Walsh and Gilles, 1977; Dick and Matsuo, 1988). As the noodles, spaghetti, etc., are pressed through the dies, they are cut to a desired length which can be controlled by the speed of the rotating knives (Walsh and Gilles, 1977). After the shaped pasta is cut, the long goods (spaghetti) are hung on racks while the short goods (macaroni) are set on screens for a brief airing. If the noodles are to be sold as fresh, they must be refrigerated until the point of cooking. If the noodles

are to be sold as shelf stable, the moisture content must be reduced from 30% to about 12-13% (Walsh and Gilles, 1977).

The Drying Process

Drying is a very critical process because, if done improperly, the end product will be brittle and will fragment upon cooking. If the pasta is dried too rapidly, cracking (checking) will occur, but if dried too slowly, the pasta will become spoiled or moldy (Walsh and Gilles, 1977).

The drying operation occurs in two main stages. First, the pasta is predried at about 65°C for one hour at a relative humidity of 65% to reduce its moisture content from 31% to 25%. This process produces case hardening so that the pasta pieces will not stick together. Pasta then enters the second stage of drying by decreasing and maintaining the temperature at 54°C with a variety of substages. First, the product is exposed to a relative humidity of 95% for 1.5 hours. "This is called the 'sweating' or rest period where the product is equilibrated with high humidity air." Next, the pasta is exposed to a relative humidity of 83% for 4 hours to bring the moisture content down to 18%. Then, the pasta is exposed to a relative humidity of 70% for approximately 6 hours to finish the drying process and bring the moisture content to 12-13%.

Finally, pasta is cooled to room temperature and packaged (Walsh and Gilles, 1977).

Proposition: Pasta As a Dessert

Desserts

Manufacturing of pasta and its processing has been highly developed throughout the years, but use of pasta has been limited to soups, pasta salads, side dishes, and entrees. However, desserts using pasta should not be ruled out as a possibility because Americans adore sweets. Each consumes about 58 kg of sugar per year or nearly 142g of sugar every day! (Brody, 1982). Also, most American desserts use flour from wheat as a key ingredient (Freeland-Graves and Peckham, 1987). Therefore, a dessert using pasta could be economically appealing.

Sugars' Effects on Pasta

When sugar is incorporated into a pasta dough, several effects will occur such as modifications of gels formed by egg, starch, and gelatin. Sugar raises the coagulation temperature of egg and flour proteins and tenderizes products because it competes with flour proteins for water during mixing. "It dehydrates pectin micelles to permit pectin gels to form" (Campbell et al., 1979). Thus, if apple juice is used as a sweetener in pasta manufacturing, it could either decrease or increase the firmness of the end product. The pectin with sugar might make a firmer

pasta, or, the sugar with protein and starch may tenderize the pasta, making it mushy.

Apple Juice Concentrate As a Sweetener

Apple juice concentrate can be an excellent flavoring and sweetening agent. It contains a large amount of sugar in addition to being rich in apple flavor and aroma. The highest monosaccharide in apple juice is fructose (16-32%), which is a powerful sweetener and humectant. Sucrose and glucose are also present at 5-16% and 4-8%, respectively (Aitken, 1954; Moyer and Aitken, 1980).

Acids' Effects. Not only is apple juice concentrate a sweetener, but it also contributes pectin materials and a relatively large amount of malic acid and smaller amounts of citric and other acids (Aitken, 1954). The addition of acids to flour doughs decreases the gelatinization power of the starch and curdles (denature) the wheat proteins (Freeland-Graves and Peckham, 1987). The presence of pectin materials can influence the dough properties if they react with sugars and acids to form gels (Moyer and Aitken, 1980; Campbell et al., 1979). These same reactions may occur in pasta dough.

Minimizing Diffusion. Another factor to consider is the problem of apple flavor leeching out into the boiling water during the cooking of pasta. To avoid diffusion of sugars and flavoring agents, a boiling medium with high

molecular concentration can be used (Freeland-Graves and Peckham, 1987; Aitken, 1954). Apple juice, with its high sugar concentration, could perhaps serve as boiling medium.

Sensory Evaluation

Introduction

Sensory evaluation is a critical marketing tool in food product development. It is necessary for objective evaluation of a food product. Therefore, it is important to perform sensory evaluation which will accurately represent the opinions of consumers to determine if a product is market-worthy (Schaefer, 1979).

Sampling Size

In order to conduct a valid sensory evaluation, a random selection (sampling) of people (panelists), who can judge objectively, must be acquired to taste and rate the product. The methods used for acquiring a group of people for taste-testing or sensory evaluation are known as sampling methods (American Society for Testing and Materials, 1968).

The easiest sampling method for taste panelists is the inplant panelists because they are chunk or convenience samplings; they are panelists simply because they happen to be on location at the time of testing. There is little control who attends this, but "this method has been found useful in research guidance before major business decisions

and to minimize risk prior to a full scale sensory evaluation" (Schaefer, 1979).

Using inplant people as panelists reduces the time and expense of testing, but it does not accurately represent the population of consumers. However, for a pilot test, it will accomplish a preliminary analysis and will offer insight and guidance toward the development and improvement of a new product. To adapt sensory evaluation to a university setting and population, the best sampling method would be the chunk or convenience sampling because it is simply "a sampling that uses those respondents (students, faculty, and staff) who are most convenient." This method saves money, eases labor, and enhances product quality because the energy will be focused on producing and delivering a quality product (Schaefer, 1979).

To obtain a representative population, 30 panelists are recommended, but 50 are preferred, because the larger the sampling size, the better the population representation (Bartz, 1988; American Society for Testing and Materials, 1968).

Questionnaire/Score Card

The survey questionnaire should be kept short in order to accommodate for the participants' time limitations and to minimize bother. Thus, a variety of questionnaire techniques, such as Consumer Acceptance Test, Food Action Scale Method, Hedonic Scale, and combinations thereof, have been

developed to accommodate all types of sensory evaluation (American Society for Testing and Materials, 1968).

Consumer Acceptance Test. With a consumer acceptance test, the strict controlling of distractions such as noise, odors, other people, etc. is not necessary like in traditional sensory evaluation. Much like an opinion poll, it simply determines whether or not a product is liked by questioning potential consumers. However, the questions are structured in order to determine specific attitudes. This method is quick and easy to compute. Furthermore, without the presence of an interviewer, respondents will feel less intimidation, and the interviewer cannot bias the questions (Schaefer, 1979; American Society for Testing and Materials, 1968).

Food Action Scale Method. The Food Action Scale (FACT) Method is primarily designed to be used with untrained consumers. The panelist is allowed to select on a scale the intensity of his/her perception of the characteristic of the product (American Society for Testing and Materials, 1968).

Hedonic Scale. A Hedonic Scale helps to determine the quality of the product and offers reliability at the same level as that of the FACT Method (American Society for Testing and Materials, 1968). This is a bi-polar scale with a neutral point in the middle to help depict magnitude

of attitudes, measuring degrees of like or dislike (Schaefer, 1979).

Modification of Scales. A combination/modification of the FACT Scale and the Hedonic Scale is capable of determining a consumer's perception of the food's flavor intensity, degree of texture, and overall quality. By combining or modifying scales, different research studies can determine attitudes and acceptance of a variety of new food products (American Society for Testing and Materials, 1968).

To analyze the sensory evaluation data, population means and standard deviations give a general trend of either like or dislike. Correlations of the different characteristics can be analyzed to determine whether one type of sensory quality imparts any influence either positively or negatively towards the attitude of another quality attribute. Also, the percentages of types of responses give an idea of the general trend (Bartz, 1988).

Texture Analysis

Pasta's al dente texture is an important characteristic in evaluating pasta's quality (Freeland-Graves and Peckham, 1987). Food Technology Texture Systems, using a variety of testing cells, yields reproducible objective texture data on a variety of food products, including pasta. The texture measurement system has been used often in pasta to determine the quality of the texture (Oh et

al., 1985; Jacobi and Setser, 1985; Dexter and Matsuo, 1979; Dexter and Matsuo, 1980; Oh et al., 1985; Matsuo et al., 1972; Hanna et al., 1978; Walsh, 1971). The single blunt-blade shear cell determines degree of firmness by measuring the amount of energy required to cut through a food sample (Walsh, 1970; Hanna et al., 1978).

Nutrient Analysis

The U.S. Dietary Goals state that Americans should consume no more that 30% calories from fat per day (Whitney and Hamilton, 1984). Therefore, it is important to determine the nutritional value of new food products. This can conveniently be accomplished using a computer program, such as the Food Processor® II Nutritional Analysis System (1987). This is a professional level analytical system and can be used to evaluate diet plans, average daily intakes, or make nutritional comparisons (ESHA Research, 1987).

CHAPTER III

DEVELOPMENT AND APPLICATIONS OF AN APPLE-FLAVORED PASTA

Abstract

Using a hard red winter wheat pasta dough, apple juice concentrate was added to the dough to create an apple-sweetened pasta. The apple-flavored pasta dough was boiled in apple juice to minimize diffusion of flavors into the boiling medium. A 2 X 2 ANOVA factorial design was implemented to determine effects in texture due to either the addition of apple juice concentrate to the dough, the use of apple juice as the boiling medium, or an interaction of both. Texture analysis reveals a significant ($p < 0.05$) firming effect due to the interaction between apple-flavored pasta and the apple juice boiling medium.

The apple-flavored pasta was also incorporated into a dessert product, apple ravioli, with a filling containing cooked McIntosh apples, brown sugar, granulated sugar, and margarine. Sensory evaluation was conducted using 50 untrained panelists. Sweetness, apple flavor, and overall quality were judged "acceptable," but texture was judged "too firm and rubbery." When apple-flavored pasta was compared to piecrust for nutritional content, apple pasta's nutrient makeup was superior in almost every aspect. For example, apple-flavored pasta contains 13% calories from protein, 80% calories from carbohydrates, and 7% calories from fat while piecrust contains 5% calories from protein, 35% calories from carbohydrates, and 60% calories from fat. Thus, apple-flavored pasta has a definite potential in the development of low-fat desserts.

Introduction

Pasta has long been a popular staple food. It was noted as far back as 1700 B.C.; and, around 1400 A.D., the Italians' excellent culinary skills caused pasta's surge into world wide popularity (Del Conte, 1976). Since that

time, pasta consumption has increased tremendously. For example, the United States' approximate per capita consumption of Italian-style pasta increased from 3.6 to 6.4 Kg between 1971 and 1986 (Dick and Matsuo, 1988).

Pasta's popularity is understandable. It provides substantial amounts of certain B vitamins and minerals such as iron, phosphorus, and magnesium (Lintas et al., 1988). Pasta's primary nutritional benefits are that it is high in complex carbohydrates (44g/146g), yet it is low in calories (216Kcal/146g, cooked), with only a trace of fat (0.7g/146g, cooked) (Pennington and Church, 1985). Also, and most importantly, it has an appealing, mild flavor which pleases people of all ages and cultures (Del Conte, 1976).

Normally, durum wheat, Triticum durum L, is used in the production of pasta. However, other types of wheat, such as hard red winter wheat (HRWW), Triticum aestivum L, have produced very palatable products and at lower costs than that of durum wheat (Hoseney, 1986; Kim et al., 1986; Wahem, 1990). Hard red winter wheat is a very important agricultural crop and is often produced in surplus; but only small amounts of this wheat are made into pasta (Tejada, 1982).

Normally, pasta has been incorporated into entrees, salads, and side dishes because of its mild flavor which enables blending with and enhancing of other food flavors. Surprisingly, a wheat-based product such as pasta is not

customarily used in desserts even though Americans adore desserts, and their favorite ones are primarily wheat-based, such as cookies, cakes, and pies. Yet pasta, when compared to piecrust, has 50 times less fat (Pennington and Church, 1985). Thus, substituting a dessert-flavored pasta for piecrust and adding a fruit filling could make a tasty, low-calorie, low-fat dessert. Further, adding flavor to the pasts cooking medium might also contribute flavor.

In order to give pasta dessert qualities, a fruit sweetener such as apple juice concentrate, for example, added to a pasta dough, will not only add sweetness to the product, but also impart a pleasant apple flavor and aroma. In addition, a boiling medium with a high molecular concentration will inhibit diffusion of a product's flavors (Freeland-Graves and Peckham, 1987). Therefore, boiling the apple pasta dough in apple juice may add flavor to the pasta while inhibiting diffusion of flavor from the pasta into the boiling medium.

Sugars normally contribute tenderness to flour-baked products (Freeland-Graves and Peckham, 1987; Campbell et al., 1979). However, good pasta has a firm al dente texture (Walsh and Gilles, 1977). Therefore, a dessert pasta may not be a successful product for two reasons: 1) sugars could possibly interfere with pasta's expected al dente texture; 2) or consumers may not be accustomed to pasta as a dessert item. However, the pectin in the apple juice could counteract sugars' tenderizing effect because

Campbell et al. (1979) states that pectin will react with sugar to give gelation firmness.

Procedures are available for testing consumer acceptance of a dessert pasta. Consumer acceptance is often measured using a consumer panel (of at least 30 untrained panelists) to perform sensory evaluation in order to determine the consumer's reaction to the product (Schaefer, 1979). In addition, Walsh (1971) reports that objective measures can show whether texture is altered with changes in the pasta recipe. Perhaps similar objective tests can detect texture changes when pasta recipes include sugar as in desserts.

The purpose for this research was to determine the effects of the addition of apple juice concentrate on hard red winter wheat pasta, and to develop a low-fat dessert-flavored pasta.

Materials and Methods

Developing and Preparing the Pasta Dough

Starting with an acceptable pasta dough using hard red winter wheat (HRWW), developed by researchers in the College of Home Economics at Oklahoma State University, with funding from the Oklahoma Wheat Commission, and trying a variety of sugar sources at a 10% level, by weight, such as corn syrup, maple syrup, and apple juice concentrate, a recipe with a pleasant aroma and a barely detectable sweet taste was developed. As the liquid ingredient, the sweet

juice concentrate produced an extrudable pasta dough from hard red winter wheat flour, but durum semolina did not absorb the concentrate well and could not be extruded easily.

The extrusion procedures were performed in the La Parmigiana, Model 45.0, a single-screw, noncooking extruder. The ingredients were blended/mixed in the mixing chamber for 7 minutes. Then, the dough entered the extrusion chamber and was fed through a die which formed HRWW pasta shells flavored with apple juice concentrate.

Because there was a possibility for the apple flavoring in the dough to leech out into the boiling medium, apple juice and water were both tested as boiling mediums. There was also the possibility that the boiling treatment might affect the pasta's important quality-determining factor, the al dente texture. Apple juice, with its sugar concentration, could perhaps provide the osmotic balance to prevent diffusion of apple flavor from the pasta, but its effect on the texture was unknown. Thus, water as the boiling medium was compared with apple juice for boiling the apple-flavored pasta to see which was most protective of pasta flavor and texture. Furthermore, the addition of juice concentrate might also alter the pasta's texture. Therefore, pasta shells were prepared of hard red winter wheat flour with either water or apple juice concentrate as the liquid in the doughs. Then, both pasta shell recipes

were subjected to each boiling medium and the texture of all 4 combinations tested.

Texture Analysis

Sampling Method and Measurement Strategy. Each of the 4 treatments of cooked pasta was measured for texture by choosing 30 random samples of pasta from each of the 4 pasta treatments. From each 3 pound batch condition of pasta shells, 90 pasta shells were selected because 3 shells comprised one sample. Thus, 30 samples were obtained from 90 shells. One sample of 3 noodles was chosen at random from this 90 and laid side by side under the blade of the texture measuring device, all 3 being simultaneously cut with a single descent of the blade. This was repeated 30 times. Therefore, a total of 360 shells were cut, 3 at a time, for a total of 120 cuts or descents of the blade.

Instrument Used. Pasta's al dente texture is a very important factor in determining the overall quality. Texture differences were recorded objectively using the Food Technology System Model T-1200 equipped with Model CA-1 single blade shear cell. This device measures the force (lbs) required to cut the pasta sample (Oh et al., 1985; Jacobi and Setser, 1985; Dexter and Matsuo, 1979; Dexter and Matsuo, 1980; Oh et al., 1985; Matsuo et al., 1972; Hanna et al., 1978; Walsh, 1971).

Research Design. The research followed a 2 X 2 factorial ANOVA design to detect the textural differences due to the pasta recipe, or the pasta boiling treatment, or a combination of both (Bartz, 1988). The statistical strategy defined the two independent variables, recipe and boiling treatment. Each variable was associated with two treatment conditions. The recipe treatment was either water or apple juice concentrate as the liquid in the dough. The boiling treatment was either water or apple juice as the boiling medium for cooking the pasta. Of primary interest was the possible interaction between boiling treatment and recipe. This effect was tested to determine whether the conditions of each variable combined jointly to influence the dependent variable of texture ratings.

Sensory Analysis

The apple-flavored pasta was incorporated into a dessert dish by preparing the pasta dough as ravioli, filling it will a cooked apple filling, boiling it in apple juice, and serving it with whipped cream.

Using a Consumer Acceptance Test (Schaefer, 1979), a panel of 50 untrained volunteer judges, consisting of Oklahoma State University students, faculty, staff, and off-campus customers, all of whom were patrons at the student restaurant on April 19, 1990, evaluated the dish's sensory qualities (Schaefer, 1979). The judges rated the raviolis for apple flavor, texture, sweetness, and overall quality

of the product using a 0 to 10-point graphic rating scale (Figure 1). This scale was designed by the author so that either end of the scale (0 and 10) measured extreme opinions of the product (i.e., not sweet enough, too sweet). Thus, a score of 5 represented the best grade. An exception to this rating was the question about overall quality, where a score of 10 represented the best grade and a score of 0 represented the worst grade. In addition, a single global item assessed the idea of pasta as a dessert. Means, standard deviations, and percentages were determined for each of the five quantitative items. Correlation coefficients were also calculated to detect possible relationships between the sensory qualities of interest (Williams, 1990; Bartz, 1988).

Nutrient Analysis

The apple-flavored pasta was compared to a standard piecrust recipe for nutritional characteristics using a computer program, the Food Processor® II Nutritional Analysis System. This program is a professional level analytical system and is used to evaluate diet plans, average daily intakes, or make nutritional comparisons (ESHA Research, 1987).

Research and Discussion

Texture Analysis. Results of objective texture analysis showed the preparing pasta with apple juice concentrate

Good Afternoon!

As a part of our pasta research, we are investigating using pasta as a dessert. If you don't mind, please taste this example of apple ravioli and mark the scales where they best indicate your opinion.

This is entirely voluntary. The ingredients in the ravioli are all-purpose flour, eggs, apples, apple juice, brown sugar, granulated sugar, margarine, and water. (Don't worry, you will also get your regular dessert!!)

SWEETNESS: |___|___|___|___|___|___|___|___|___|___|
not sweet perfect too sweet

APPLE FLAVOR: |___|___|___|___|___|___|___|___|___|___|
too bland perfect too strong

TEXTURE: |___|___|___|___|___|___|___|___|___|___|
soft, mushy perfect firm, rubbery

OVERALL OPINION |___|___|___|___|___|___|___|___|___|___|
terrible perfect excellent

The idea of using pasta as a dessert is:

_____ Great, we need more uses for pasta
_____ OK
_____ I don't care either way
_____ Not so good
_____ A poor idea, we have lots of desserts already

Additional comments are welcomed:

THANK YOU!!! We appreciate your cooperation!

Figure 1. Sensory Evaluation Form

and cooking the prepared pasta with apple juice had a significant effect at the $p < 0.05$ level on increasing the firmness. However, cooking plain pasta in boiling water, plain pasta in boiling apple juice, nor apple pasta in boiling water had a significant effect on the texture of the end product (Figure 2).

Sensory Analysis. Results of the subjective sensory evaluation of apple ravioli were recorded. Sensory evaluation panelists judged sweetness and apple flavor as acceptable ($\bar{x} = 5.0 + -1.0$). The texture ratings of the raviolis agree with the objective texture analysis of the pasta shells in that the product was rated slightly firm and rubbery ($\bar{x} = 6.45$). (The objective test found that the apple pasta cooked in apple juice was firmer than regular pasta.) Overall quality was judged acceptable ($\bar{x} = 5.47$). When judges were asked if they thought that pasta would make a favorable dessert, 76% (44% great, 32% OK) said that it seemed like a good idea (Table I).

Correlations were also calculated between the sensory qualities of interest: apple flavor, sweetness, texture, overall quality, and the idea of pasta as a dessert. As noted in Table II, positive ($p < 0.05$) correlations were indicated among the apple flavor and the overall quality, and the apple flavor and the idea. A strong positive correlation ($r = .63$) was noted between the overall quality and the idea. In other words, about 40% of the variation in the idea of pasta as a dessert was explained by changes

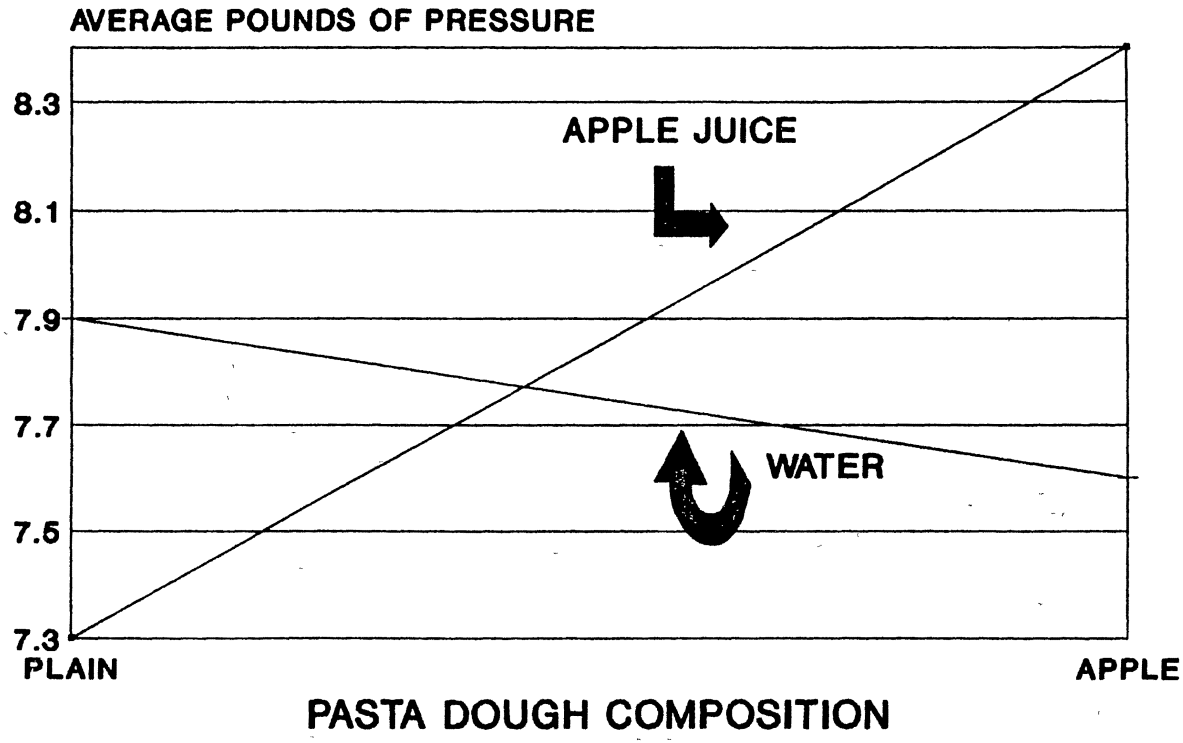


Figure 2. Interaction Effect Between Pasta Dough Recipe and the Pasta's Boiling Medium

TABLE I

FREQUENCY ANALYSIS OF THE IDEA OF PASTA AS A DESSERT

Rating	Total Number of Responses	Percent of Total
5. Great	22	44%
4. OK	16	32%
3. Don't care	5	10%
2. Not so good	5	10%
1. Poor idea	2	4%
	50	100%

TABLE II

CORRELATIONS AMONG SENSORY QUALITIES RESPONSES OF THE PASTA DESSERT

Correlations:	S	A	T	O	I
S		.09	.15	-.04	-.05
A			.01	.34*	.31*
T				-.09	-.08
O					.63*
I					

* = significant at 0.05

S = Sweetness
A = Apple Flavor
T = Texture
O = Overall Quality of the Apple Ravioli
I = Idea of Pasta As a Dessert

in the overall quality of the apple ravioli. Apple flavor also held influence on the overall quality and the idea in about 12% and 10% of the time, respectively. Thus, if people could become accustomed to the idea of pasta as a dessert, they would probably enjoy eating the apple ravioli more. Also, if the apple flavor intensity were increased, the people might think more positively about the idea of pasta as a dessert.

Nutrient Analysis. When the nutrient analysis of apple pasta was compared to that of piecrust using the Food Processor® II Nutrition Analysis System (1987), the apple pasta had some nutritional advantages (Table III). Gram per gram, the piecrust contained about 16 times more fat, and was about 80% higher in calories than the apple pasta. Furthermore, the apple pasta contained only 7% of calories from fats and 80% of calories from carbohydrates whereas the piecrust contained 60% of calories from fats and only 35% of calories from carbohydrates. This is important since dietary recommendations are that no more than 30% of daily calories come from fat (Whitney and Hamilton, 1984). Also, the apple pasta had a higher content of all vitamins and minerals with the exception of vitamins B6 and E and minerals copper and zinc being slightly lower in content (ESHA Research, 1987).

Conclusion

Americans are now more concerned about good nutrition.

TABLE III

NUTRITION ANALYSIS COMPARISON:
APPLE-FLAVORED PASTA DOUGH
VS. PIECRUST

Nutrient	Apple-Flavored Pasta Dough (100g)	Piecrust (100g)	Difference Between Apple-Flavored Pasta Dough and Piecrust
Calories	294	500	-206
Protein	9.4g	6.11g	+ 3.29
Carbohydrate	57.3g	43.9g	+ 13.4
Dietary Fiber	1.92g	2.00g	- 0.08
Fat-Total	2.32g	33.3g	- 30.98
Fat-Saturated	0.641g	8.22g	- 7.579
Fat-Mono	0.692g	14.4g	- 13.702
Fat-Poly	0.557g	8.72g	- 8.163
Cholesterol	64.3mg	0.0mg	+ 64.3
Vit A-Total	30.0RE	0.0RE	+ 30.0
Thiamin-B1	0.459mg	0.300mg	+ 0.159
Riboflavin-B2	0.362mg	0.222mg	+ 0.140
Niacin-B3	3.74mg	2.78mg	+ 0.96
Pyridoxing-B6	0.062mg	0.094mg	- 0.032
Cobalamin-B12	0.140mcg	0.0mcg	+ 0.140
Folacin	18.4mcg	17.8mcg	+ 0.6
Pantothenic	0.512mg	0.227	+ 0.285
Vitamin C	0.190mg	0.0mg	+ 0.190
Vitamin E	1.07mg	1.39mg	- 0.32
Calcium	21.0mg	13.9mg	+ 7.10
Copper	0.099mg	0.128mg	- 0.029
Iron	3.44mg	2.50mg	+ 0.94
Magnesium	18.2mg	7.2mg	+ 1.00
Phosphorus	93.2mg	50.0mg	+ 43.2
Potassium	126mg	50.0mg	+ 76.0
Selenium	25.2mcg	16.4mcg	+ 8.8
Sodium	24.6mg	611mg	-586
Zinc	0.665mg	0.833mg	- 0.168
Calories from:			
Protein	13%	5%	+ 8
Carbohydrates	80%	35%	+ 45
Fat	7%	60%	- 53

(ESHA Research, 1987)

They want foods low in fat, but they want foods that are still good-tasting and satisfying. Piecrust is about 16 times higher in fat content than apple-flavored pasta. Also, sensory evaluation indicates that apple ravioli is an acceptable dessert. Thus, apple-flavored pasta carries potential as a new low-fat dessert product.

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CHAPTER IV

RESULTS, DISCUSSION, RECOMMENDATIONS AND HYPOTHESES TESTING

The Texture Analysis

The Interaction Effect

Apple juice concentrate was added to pasta dough for flavor, aroma, and the potential for developing dessert dishes with the dough. Pastas made with and without apple juice concentrate were then boiled in either water or apple juice. To determine whether the apple juice concentrate affected the pasta dough's texture, texture measurements were taken and analyzed. To display the interaction effect between the two variables: pasta recipe and boiling treatment, the means (Table III) of textural data are plotted in Figure 2.

Because the lines in Figure 2 are clearly not parallel, Bartz (1988) explains that this indicates a significant interaction effect when apple pasta was boiled in apple juice. In addition, the ANOVA Summary Table (Table IV) also shows that a significant interaction existed between the recipe and the boiling medium.

TABLE III

MEAN VALUES FOR TEXTURE MEASUREMENTS OF PASTA CONDITIONS TESTED (IN LBS OF PRESSURE)

		Pasta Dough Recipe	
		Plain	Apple
Boiling Medium	Apple	7.3	8.4
	Water	7.9	7.6

Analysis of Texture Variance

TABLE IV

ANALYSIS OF VARIANCE OF TEXTURE MEASUREMENTS OF PASTA CONDITIONS TESTED

source	S.S.	d.f.	M.S.	F
boil	.1333008	1	.1333008	.1319359
pasta	4.799805	1	4.799805	4.750657
B X P	13.3335	1	13.3335	13.19697*
S/B X P	117.2001	116	1.010345	
Total	135.4667	119		

* Significant at $p < .05$

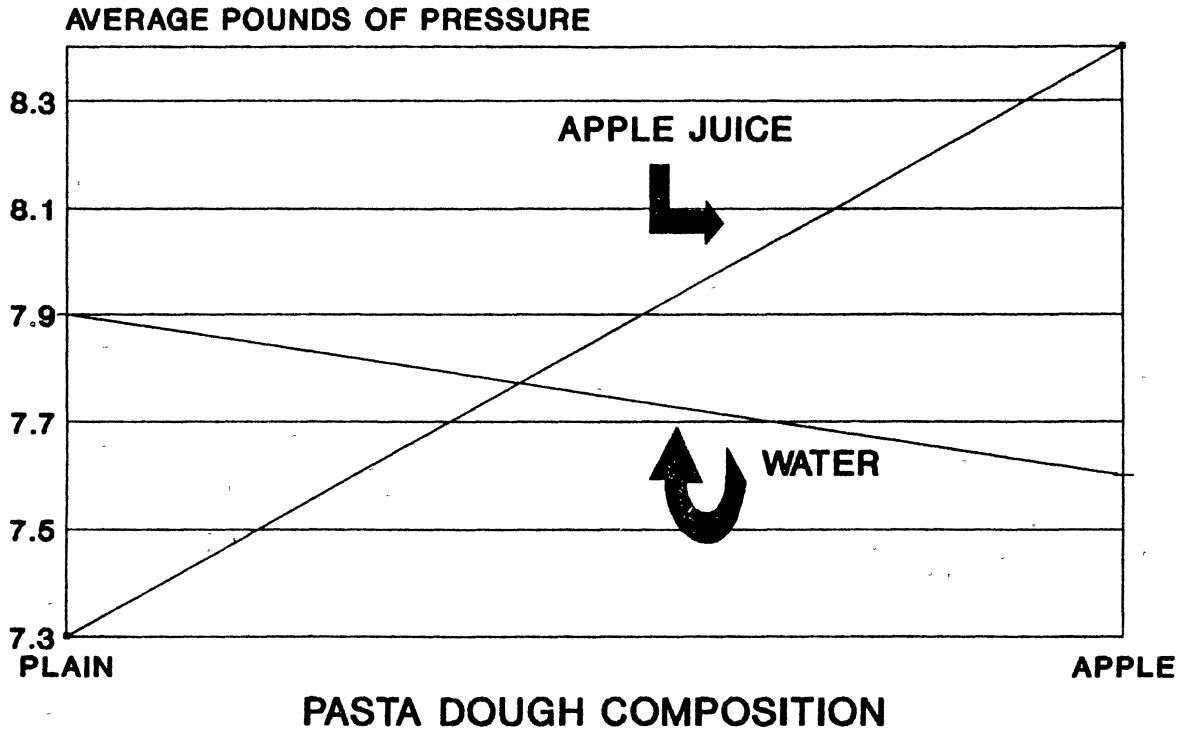

Figure 2. Interaction Effect Between Pasta Dough Recipe and the Pasta's Boiling Medium

Both the table of means and the ANOVA Summary Table provide information on the major effects tested in this study. Table IV indicates that the interaction effect was the only effect to reach statistical significance. It should be noted that the test associated with this effect was associated with a single degree of freedom test. Therefore, the interaction was directly interpreted.

The significant interaction suggested that both the boiling solution and type of pasta affected the firmness in pasta texture in that the firmest texture was produced by boiling the apple pasta in apple juice. The least firm condition involved the apple pasta in plain water. This is maybe due to minimizing the diffusion of apple juice components (pectin, malic acid, fructose, etc.) and their reaction with pasta. There were no significant differences in texture when either plain or apple pasta was boiled in water nor when plain pasta was boiled in apple juice.

Sensory Analysis

The dough was prepared as a dessert, apple filled ravioli, and evaluated by a sensory panel consisting of 50 untrained, volunteer panelists. They evaluated the apple ravioli for sweetness, apple flavor, and texture on a hedonic-type scale, and overall quality on a Food Action Scale Method (American Society for Testing and Materials, 1968). Figure 3 illustrates the sensory evaluation form, Figure 4 shows the frequency distribution of panelists'

Good Afternoon!

As a part of our pasta research, we are investigating using pasta as a dessert. If you don't mind, please taste this example of apple ravioli and mark the scales where they best indicate your opinion.

This is entirely voluntary. The ingredients in the ravioli are all-purpose flour, eggs, apples, apple juice, brown sugar, granulated sugar, margarine, and water. (Don't worry, you will also get your regular dessert!!)

SWEETNESS: |___|___|___|___|___|___|___|___|___|___|
not sweet perfect too sweet

APPLE FLAVOR: |___|___|___|___|___|___|___|___|___|___|
too bland perfect too strong

TEXTURE: |___|___|___|___|___|___|___|___|___|___|
soft, mushy perfect firm, rubbery

OVERALL OPINION: |___|___|___|___|___|___|___|___|___|___|
terrible perfect excellent

The idea of using pasta as a dessert is:

_____ Great, we need more uses for pasta
_____ OK
_____ I don't care either way
_____ Not so good
_____ A poor idea, we have lots of desserts already

Additional comments are welcomed:

THANK YOU!!! We appreciate your cooperation!

Figure 3. Sensory Evaluation Form

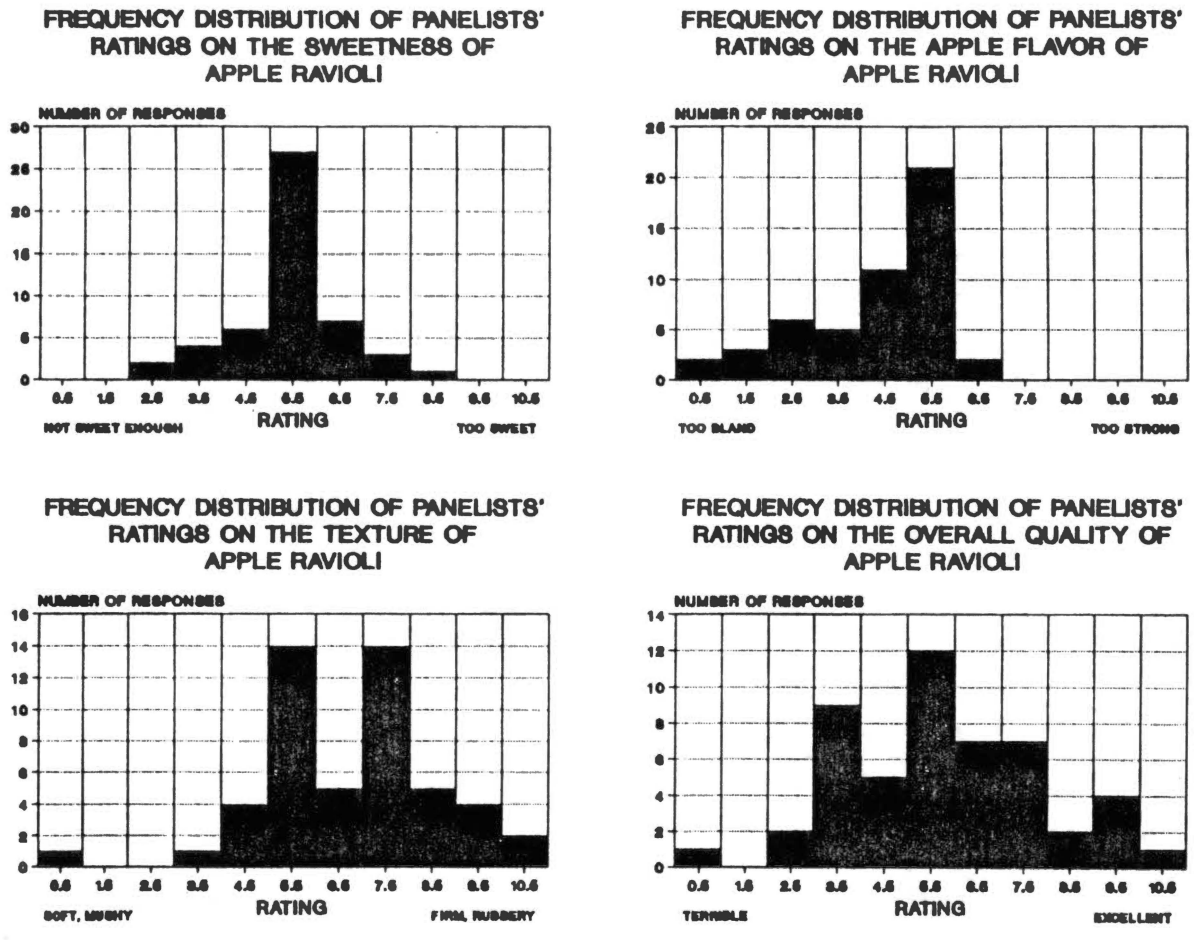

Figure 4. Frequency Distribution of Panelists' Ratings on Sensory Attributes

responses for sensory qualities tested, and Table V lists the results of the sensory qualities analyses.

TABLE V

MEANS AND STANDARD DEVIATIONS FOR SENSORY QUALITIES TESTED

Sensory Qualities	Mean	Standard Deviation
Sweetness	5.07	1.14
Apple Flavor	4.00	1.46
Texture	6.45	1.87
Overall Quality	5.47	2.08

With a rating of 5.0 + -1.0 as acceptable, according to Table V, panelists rated the sweetness almost perfectly ideal. The apple flavor was rated just slightly bland. Texture was rated a little too firm and rubbery, and this matches the results of the objective texture measurements. The overall quality was rated acceptable (acceptable = between 5.0 and 10.0); and although the standard deviation is large, this is to be expected when working with untrained human beings and their naturally varied opinions.

A single global item was assessed in order to determine people's overall attitudes of having pasta incorporated into a dessert product (Table VI).

TABLE VI

FREQUENCY ANALYSIS OF THE IDEA OF PASTA AS A DESSERT

Rating	Total Number of Responses	Percent of Total
Great	22	44%
OK	16	32%
Don't care	5	10%
Not so good	5	10%
Poor idea	2	4%
	50	100%

On the whole, over three-fourths of the panelists liked the idea of pasta as a dessert (Figure 5). Therefore, there is a positive incentive to continue research with pasta desserts.

Correlations were also studied in order to note whether any influence existed between the various sensory qualities and attitudes (Table VII).

The correlation table indicates significant positive relationships existed between: 1) the overall quality and the idea of using pasta as a dessert, 2) the apple flavor and the overall quality, 3) and the apple flavor and the idea. Thus, by increasing or enhancing the apple flavor in the product, overall acceptance might increase. Also, people's positive reception toward a pasta dessert product would increase in an increase in apple flavor. If people

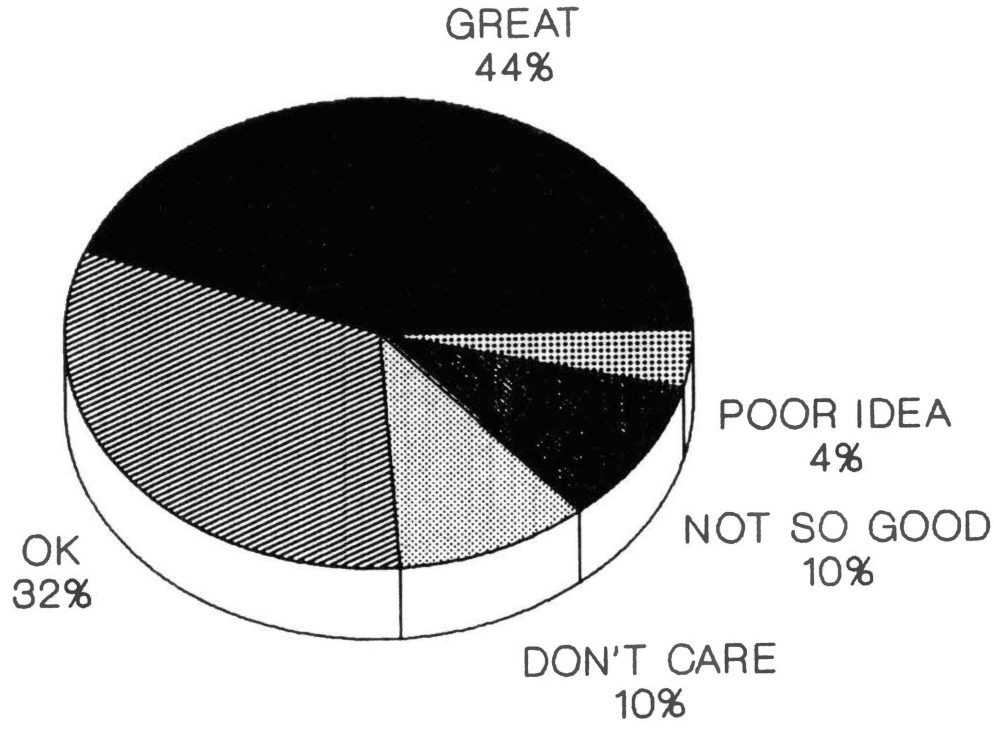

Figure 5. Percentage of Respondants' Ratings of the Idea of Pasta as a Dessert

TABLE VII

CORRELATIONS AMONG SENSORY QUALITIES
RESPONSES OF THE PASTA DESSERT

Correlations:	S	A	T	O	I
S		.09	.15	-.04	-.05
A			.01	.34*	.31*
T				-.09	-.08
O					.63*
I					

* = significant at 0.05

S = Sweetness
A = Apple Flavor
T = Texture
O = Overall Quality of the Apple Ravioli
I = Idea of Pasta As a Dessert

could become accustomed to the idea of pasta as a dessert, they would probably enjoy eating the apple ravioli more. Also, if the apple flavor intensity were increased, the people might hold a higher opinion about the idea of pasta as a dessert.

According to Basic Statistical Concepts, by Bartz (1988), the coefficient of determination (or the squared correlation coefficient) yields information that allows for the practical interpretation of statistically significant results. In the current study, the overall quality of the

pasta dessert and the idea of using pasta as a dessert (with an r of .63), yielded an r-squared close to .4. This indicates that about 40% of the variation in the idea was explained by changes in overall pasta quality. Likewise, the apple flavor influenced the overall quality, (about 12% of the time), and it also influenced the idea (about 10% of the time).

Nutrient Analysis

The final analysis conducted compared the nutritional values of apple pasta and piecrust. The Food Processor® II computer program was used for this comparison which demonstrates that the apple pasta is nutritionally superior to piecrust due to apple pasta's low fat, high carbohydrate content. Gram per gram, the piecrust contains about 16 times more fat, and is about 80% higher in calories than the apple pasta. Furthermore, the apple pasta contains only 7% of calories from fats and 80% of calories from carbohydrates whereas the piecrust contains 60% of calories from fats and only 35% of calories from carbohydrates. U.S. Dietary recommendations are that dietary fat be reduced and no more than 30% of calories daily be from fat. Dessert pastas might, therefore, be a healthy alternative to piecrust. Also, the apple pasta contains a higher content of all vitamins and minerals with the exception of vitamins B6 and E and minerals copper and zinc.

TABLE VIII

NUTRITION ANALYSIS COMPARISON:
APPLE-FLAVORED PASTA DOUGH
VS. PIECRUST

Nutrient	Apple-Flavored Pasta Dough (100g)	Piecrust (100g)	Difference Between Apple-Flavored Pasta Dough and Piecrust
Calories	294	500	-206
Protein	9.4g	6.11g	+ 3.29
Carbohydrate	57.3g	43.9g	+ 13.4
Dietary Fiber	1.92g	2.00g	- 0.08
Fat-Total	2.32g	33.3g	- 30.98
Fat-Saturated	0.641g	8.22g	- 7.579
Fat-Mono	0.692g	14.4g	- 13.702
Fat-Poly	0.557g	8.72g	- 8.163
Cholesterol	64.3mg	0.0mg	+ 64.3
Vit A-Total	30.0RE	0.0RE	+ 30.0
Thiamin-B1	0.459mg	0.300mg	+ 0.159
Riboflavin-B2	0.362mg	0.222mg	+ 0.140
Niacin-B3	3.74mg	2.78mg	+ 0.96
Pyridoxing-B6	0.062mg	0.094mg	- 0.032
Cobalamin-B12	0.140mcg	0.0mcg	+ 0.140
Folacin	18.4mcg	17.8mcg	+ 0.6
Pantothenic	0.512mg	0.227	+ 0.285
Vitamin C	0.190mg	0.0mg	+ 0.190
Vitamin E	1.07mg	1.39mg	- 0.32
Calcium	21.0mg	13.9mg	+ 7.10
Copper	0.099mg	0.128mg	- 0.029
Iron	3.44mg	2.50mg	+ 0.94
Magnesium	18.2mg	7.2mg	+ 1.00
Phosphorus	93.2mg	50.0mg	+ 43.2
Potassium	126mg	50.0mg	+ 76.0
Selenium	25.2mcg	16.4mcg	+ 8.8
Sodium	24.6mg	611mg	-586
Zinc	0.665mg	0.833mg	- 0.168
Calories from:			
Protein	13%	5%	+ 8
Carbohydrates	80%	35%	+ 45
Fat	7%	60%	- 53

(ESHA Research, 1987)

Recommendations and Conclusions

An apple-flavored pasta product has proven to be an acceptable product. However, further development in the formulation of the apple pasta product could improve the sensory quality. For example, enhancing the apple filling with spices (nutmeg and cinnamon) may increase the overall perceived quality of the product.

The texture of the apple-flavored pasta product showed significant firming due to the interaction between the addition of concentrated apple juice in the pasta dough and the application of apple juice as the pasta's boiling medium. Additional studies should be conducted to pinpoint which of the apple juice's and concentrate's specific components (malic acid, pectin, citric acid, fructose, etc.) caused the significant change in texture.

Americans want to be thin but they want to enjoy desserts too. By developing more low-fat dessert products, like apple-flavored pasta, people can enjoy good eating and good health.

Hypotheses Testing

The first hypothesis stated that there would be no difference in texture when apple juice concentrate was incorporated into a conventional pasta dough. In statistical analysis of texture, there was no difference in texture when apple juice concentrate was incorporated into a con-

ventional pasta dough, unless the apple-flavored pasta dough was boiled in apple juice.

The second hypothesis stated that a dessert which would incorporate the apple-flavored pasta dough would be high in fat (greater than 30% calories from fat). Nutrient analysis indicated that apple-flavored pasta dough contained just 7% calories from fat and the apple pie filling contained 27% calories from fat. Therefore, a dessert pasta which incorporates the apple-flavored pasta dough is not high in fat.

The third and final hypothesis stated that a dessert which would incorporate the apple-flavored pasta dough would be judged "not acceptable" by the sensory evaluation panelists. In statistical analysis of sensory attributes of sweetness, apple flavor, and overall quality, panelists judged these to be "acceptable." The remaining attribute, texture, however, was judged "not acceptable."

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APPENDIX

OPTIONAL COMMENTS OFFERED BY THE SENSORY EVALUATION PANELISTS ON APRIL 19, 1990

1. It is a different idea for pasta, but I really like it!
2. Leaves pasta after-taste.
3. Need chunkier filling; something to bite into. Really good.
4. Add cinnamon.
5. Good, but needs lots of center filling.
6. No comment.
7. No comment.
8. No comment.
9. No comment.
10. Very good idea!
11. No comment.
12. More apple flavoring.
13. Excellent filling taste.
14. No comment.
15. Innovative concept. Excellent taste.
16. No comment.
17. Not bad. Color needed.
18. Try phyllo dough instead of pasta.
19. No comment.
20. Hard concept to accept.
21. All other apple desserts are far superior without pasta.
22. More apple in ravioli.
23. I think it is very original and very tasty.
24. Very tasty, use dried fruits.
25. More cinnamon and apples.
26. No comment.
27. Too bland--maybe add cinnamon or more tartness.
28. Needs more filling.
29. A very attractive product.
30. Would have liked to try the pasta without whipped cream.
31. More apple filling.
32. No comment.
33. No comment.
34. Needs more flavor or different texture.
35. More apple filling.
36. I wouldn't bother.

37. Tasty, but I wouldn't order it or buy it.
38. I like it but it's hard to get used to the idea of sweet pasta.
39. Perhaps a name in place of ravioli.
40. As a dessert, it is undesirable.
41. I think it may be good, but without whipped topping.
42. No topping needed.
43. Do not use plastic plates.
44. Do not use plastic plates.
45. No comment.
46. It was very good.
47. Very good. Try ice cream on top.
48. More coloring needed.
49. No comment.
50. No comment.

VITA

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