ACCEPTANCE OF BREAD WITH PARTIAL REPLACEMENT OF WHEAT BREAD FLOUR BY POTATO PRODUCTS IN SELECTED REGIONS OF THE USSR AND USA

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(ABSTRACT)

The purpose of this research was to incorporate a potato product into bread as a partial replacement for wheat flour and to describe a collaborative process for the development of bread products in three Soviet communities.

Six potato flake breads and six cooked-mashed potato breads, with and without added gluten, were evaluated in a pilot study. Consumer acceptance scores indicated no significant differences among the twelve bread products. Four bread products, 29% and 45% cooked-mashed potato breads without added gluten, 15% potato flake bread with added gluten, and a 100% wheat flour bread, were selected for objective measurements, descriptive sensory evaluation, and central location acceptance testing.

The four breads were not significantly different in the objective measurements of standing height, percent protein and amino acid content. The three potato breads had the highest moisture percent loss on day 1. Texture analysis indicated the 45% bread had the highest texture measurements from the day of baking through day 4. The control "rapid" bread had the lowest analysis

of freshness measurements. Staling, as measured by differential scanning calorimetry, indicated the potato breads had significantly reduced staling rates when compared to 100% wheat flour bread.

Eleven trained panelists judged ten characteristics of the control and potato breads. The panelists perceived the potato breads to be more moist than the control. The other sensory characteristics of the control and potato breads were judged as similar.

Central location acceptance testing in Alaska and the Soviet Far East indicated that the potato breads were acceptable and consumers indicated they would buy the breads if they were available. Across all locations the locally purchased control bread was liked significantly less than the potato breads.

A collaborative process was designed for development of food products in Soviet and Alaskan communities.

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CHAPTER I

INTRODUCTION

East meets West at the Bering Sea, the body of water that divides the northeastern coastline of the Union of Soviet Sovereign Republics (USSR) and the northwestern coastline of the forty-ninth of the United States, Alaska. The close proximity of these two regions results in similarities of geography and soils and the necessity to adapt lifestyles to tundra and subarctic climates. Although the multiple cultures that represent the populations of these two regions are unique, the problems associated with living in a remote terrain, where small populations inhabit large geographic areas, are analogous.

During a scientific exchange to the Soviet Far East, sponsored by the University of Alaska's Institute for Circumpolar Health and the USSR Institute of Biological Problems of the North, in July 1989 the observation of two factors, bread rationing and an abundant potato crop, were linked to form the rationale for this research proposal.

In the communities of New Chaplino, Anadyr, and Magadan, located in the Magadan Region of the Soviet Far East, the rationing of bread was begun in August of 1989. Bread is a low priced, staple food item for consumers in these communities. Ingredients for bread must be transported, most often by airplane, to the rural community bakeries. Low bread prices are maintained through government subsidies.

The Magadan Region harvests 20,000 tons of potatoes annually (Magadan Ministry of Agriculture, 1991). The crop is harvested primarily from state farms but individuals also grow potatoes in their garden plots. Losses due to post-harvest handling, distribution and storage of this bulky and perishable crop are high. Post-harvest processing into primary or intermediate food products does not take place (Magadan Ministry of Agriculture, 1991).

Yeast bread products that partially replace wheat flour with potato products, such as boiled-mashed potatoes or potato flakes, may have the potential of reducing the subsidized cost of the bread, increasing the utilization of the abundant and locally grown potato crop, and increasing food security by increasing the availability of this staple food.

In the United States, Alaska is the Bering Sea neighbor of the Magadan Region of the Soviet Far East. Alaska does not have a major potato harvest even though agricultural research has developed potato varieties that have the potential of abundant harvests in this northern climate (Vandre, 1989). The major factors limiting the potato harvest in Alaska are problems with post-harvest handling, distribution, processing, and storage. These limiting factors resembled the ones identified in the Soviet Far East, and since Alaska and the Soviet Far East share common intrinsic factors, parallel research in the two regions was conducted. Another rationale for parallel potato bread research in Alaska was to lend validity to the research carried out in the Soviet Far East. In international settings, research participants may prejudge the value of a food product based on its acceptability in the researcher's country of origin.

The purpose of this research was to incorporate an underutilized, accessible product as a partial replacement for an imported product in a staple food such as bread and to define a collaborative process for the development of the food product in international communities. The objectives for the research were: 1) to determine the optimum replacement of wheat flour with potato products in objective and sensory laboratory tests, 2) to determine the acceptance of the breads in one Alaskan community and three communities in the Soviet Far East, 3) to complete a descriptive sensory evaluation of the bread product's characteristics using a trained panel, and 4) to describe a collaborative process for development of bread products in three Soviet communities.

CHAPTER II

REVIEW OF LITERATURE

2.00 Introduction

This review of literature discusses the historical and current knowledge that provided the background for the purpose and objectives of this research. The production and properties of wheat and potatoes were evaluated for their role as ingredients in bread products. An overview of the major classifications of sensory evaluation methodology provided the basis for the three types of sensory testing carried out in this research. A brief discussion of qualitative evaluation, as a form of market research, is presented as background for the questionnaire designed to accompany the central location acceptance testing. The components of the development process, with a focus on international agricultural projects, is defined as a foundation for the collaborative process used in developing the international emphasis of this research.

2.01 World Production of Wheat and Potatoes

Wheat production ranks as the most widely grown food crop in the world. Wheat can be cultivated from northern latitudes of approximately 25 degrees to the most southern locations in South America. Wheat will grow at elevations from sea level to 3,000 meters (Bushnuk, 1986).

In 1983, world wheat production was 499.8 million tons, making wheat the most abundant cereal crop. The People's Republic of China, Soviet Union, and United States produced 84 million tons, 75 million tons, and 74 million tons of wheat respectively, in 1984-1985. Developing countries such as India, are becoming major world wheat producers by the cultivation of wheat varieties that are high-yielding and fertilizer responsive (Bushnuk, 1986).

Potato production ranks among the top five of the world's crops in tonnage, nutritive and monetary value. Traditionally the potato is an European and temperate climate crop. However, during the 1980s, potato production in developing countries and tropical and subtropical climates expanded rapidly (IPC, 1985a; Horton and Sawyer, 1985).

In 1985, approximately 33 percent of the world's potato crop was grown in developing countries, 60 percent in Europe, and 10 percent in other developed countries (Horton, 1987). In 1983, according to the International Potato Center's Potato Atlas, the USSR had the largest potato production (72,387 million tons), with China second (55,775 million tons), Poland third (33,635 million tons), and the USA fourth (14,979 million tons) (IPC, 1985a).

2.02 Potato Crops in Alaska and the Soviet Far East

The tundra and subarctic climates and the tundra, podzol, and mountain and valley soils of Alaska and the Soviet Far East limit agricultural crops to hardy varieties of vegetables, potatoes, hay, and barley (Wheeler and Kostbade, 1990). Wheat is not grown in these regions.

The Soviet Far East harvested approximately 20,000 tons of potatoes in 1989 (Magadan Ministry of Agriculture, 1990). Potatoes are grown on state farms and on private plots of land. The early potato variety, Prejekulskii ranni, is the most abundant of the three varieties grown in the region on state and private lands. The potatoes are manually harvested into net bags and then stored in bulk at the farms where they are harvested. Although storage areas on state farms are equipped with forced air ventilation, the storage facilities are not adequate for long term storage of large quantities of this crop, which results in storage losses (Magadan Ministry of Agriculture, 1990). Post-harvest processing of the raw potato into primary or intermediate food products does not take place. The consumer demand for potatoes is greater than the supply, even when the state farm potato crop is supplemented at the open market with crops from private lands. The Magadan region has the agricultural potential to grow larger crops of potatoes if secondary uses or products were developed that would help limit long-term storage losses (Magadan Ministry of Agriculture, 1990).

According to the Department of Natural Resources (1991), the state of Alaska harvested 590 acres of potatoes at a yield of 234 tons per acre. The total harvest was 138,000 tons with an estimated dollar value of $2,677,000. Wayne Vandre (1990), Horticulture Specialist with the University of Alaska, stated that the annual harvests have been limited because of problems with post-harvest handling, distribution, storage and lack of secondary uses or products for the potatoes harvested, and high storage losses.

2.03 Potato Structure

The potato belongs to the family Solanaceae which also includes plants such as tobacco, tomato, eggplant, and pepper. The tuber of the potato is the enlarged underground portion of the stem. The epidermis is the outer layer of cells, below which is the periderm. These two layers together form the potato's "corky celled" skin. The fleshy, or starch portion, of the potato consists of the outer and inner medulla (Horton, 1987; Horton and Sawyer, 1985).

2.04 Potato Varieties

Russet Burbank is the potato variety that accounts for approximately 97% of the potatoes marketed with "Idaho" on the label (Johannson, 1990). Varietal characteristics of this potato tuber are: late maturity; large, long, with russeted and heavily netted skin and numerous shallow eyes; excellent cooking quality for baking, French fries, and processing. Red La Soda and Red Pontiac are commonly known by consumers as "red" potatoes because of their intense red skins. Varietal characteristics of these potato tubers are: medium to late maturity; semi-round to oblong shape with smooth to flaky, deep to dark red skins; white flesh that cooks white (Smith, 1968).

Varieties that have been adapted to growing conditions in Alaska are Kennebec, Superior, and Bay King. These three varieties comprise the majority of the harvested potatoes in Alaska (Carling, 1991). Varietal characteristics of Kennebec tubers are: midseason to late maturity; oblong shape with shallow eyes; white skin and flesh; cooks white and makes good chips. Varietal characteristics of Superior tubers are: early to medium maturity; oval shape with shallow eyes and smooth to flaky skin; high total solids and makes good chips; cooks white (Smith, 1968).

In the Soviet Far East the primary potato variety harvested is Prejekulskii ranni. Varietal characteristics of this tuber are: early maturity; oval-round shape with moderately deep eyes and white skin; white flesh; reasonable cooking quality; and 10 to 17% starch.

Potato varieties adapted to northern climates tend to vary in total solids and moisture content. Potatoes grown in these regions tend to have low total solids and high moisture content. The moisture content of potatoes is generally considered to be related to variety rather than growing conditions. The water content of potatoes is approximately 95%. Total solids content of potatoes is primarily a function of climate; Fall potatoes have a higher total solids contents than Spring potatoes (Johannson,1990; Zapsalis and Beck, 1986).

2.05 Potato Starch

The dry matter content of the potato averages about 20 percent of the whole tuber (Horton, 1987; Smith, 1968). Starch constitutes about 65-80 percent of the dry matter. Potato starch granules are ellipsoidal with an average dimension of 100μm X 60μm. Compared to wheat starch granules, potato starch granules are significantly larger (Jain and Sherman, 1976).

The major molecular components of the potato starch granule are amylose and amylopectin. These molecules maintain an average ratio of 1:3 in all potato varieties (Smith, 1968). Potato varieties such as Red La Soda, Red Pontiac, and Prejekulskii ranni are characterized as waxy potatoes with starch granules that have lower levels of amylose when compared to mealy potatoes such as Russet Burbank (Zapsalis and Beck, 1986; Paul and Palmer, 1972).

Phosphorus is a minor component of potato starch that exists in chemical combination with the starch as an esterified orthophosphate. It is located at the C-6 position of the glucosyl residue of amylopectin. Grain starch amylopectin does not contain esterified orthophosphate. When potato starch is hydrated the viscosity of the gel depends on the ionization of a small amount of the esterified phosphate-amylopectin complex. The high swelling capacity of potato starch is partially due to the ionized esterified phosphate groups (Jain and Sherman, 1976).

2.06 Potato Protein and Energy Content

Approximately 1-1.5 percent of the dry matter of potatoes is protein. The proteins are 60-70 percent globulins and 20-40 percent glutelin. No albumins, gliadins, or glutenins are present (Smith, 1968). Therefore the proteins of potato cannot form a gluten complex.

As a crop, potatoes can be compared to wheat in terms of edible energy and protein per hectare per day. The edible energy production per hectare per day for potatoes is 216 MJ, for wheat it is 135 MJ. The protein production for potatoes per hectare per day is 1.4 Kg, for wheat it is 1.3 Kg (Horton and Fano, 1985). Therefore, when production efficiency is considered, potatoes yield more energy and slightly more protein than wheat per hectare per day.

The chemical scores and net protein utilization of potatoes and white flour can also be compared (Egg as the standard) = 100 Chemical Score and Net Protein Utilization). Potatoes have a chemical score of 70 and a net protein utilization of 71. White flour has a chemical score of 50 and a net protein utilization of 52 (Horton and Fano, 1985). The protein of potato ranks higher than wheat protein when these nutritional quantifications are used. As a crop and as a source of nutrients, potatoes are efficient as a partial replacement for wheat flour in bread.

2.07 Potato Products Used in Breadmaking

In 1932, an article in the Canadian Journal of Research by R.H. Harris reported his research of the use of cooked potato in baking bread. The Harris research, along with later research by Jain and Sherman (1974), Kissell and Yamazaki (1975), Knorr (1977), Knorr, Kohler and Betschart (1978), Buck, Walker, and Watson (1987), and Paredes-Lopez, Barba-Rosa, and Gozalez-Castaneda (1987) show results consistent with one another and consistent with what is known about the structures of wheat and potatoes. Those results indicate that regardless of the form of the potato starch, replacement levels of wheat flour with potato products are limited. The protein network formed by gluten can support between 10 and 20 percent replacement of the wheat flour with a non-gluten forming starch. Higher levels of replacement result in undesirable sensory qualities.

Harris' (1932) early research detailed the benefits of adding potato to bread products. He reported that cooked potato increased gas production in the bread dough which increased the loaf volume and improved crumb color. Jain and Sherman (1974) reported that addition of potato to bread products improves quality and moisture retention and retards staling.

2.08 Structure of Wheat

The wheat kernel can be divided into three distinct parts:

(1) The endosperm, which comprises about 83 percent of the kernel, consists of the starchy endosperm and the aleurone layer. The endosperm is 80 percent carbohydrate, 12 percent protein, 2 percent fat, and 1 percent minerals and other components.

(2) The bran, which forms about 14 percent of the kernel and consists of at least 6 different tissue layers. The bran is 70 percent carbohydrate, 17 percent protein, 5 percent fat and 7 percent minerals and other components.

(3) The germ, forms about 3 percent of the kernel and includes the scutellum with the embryo. This part is 50 percent carbohydrate, 32 percent protein, and 12 percent fat (Bushnuk, 1986).

2.09 Wheat Carbohydrates

The primary carbohydrates of wheat are starch, dextrins, cellulose, and several types of sugars and pentosans. The starch is found in the colorless plastids (leucoplasts) of plant cells. The main function of starch is carbohydrate reserve for the wheat kernel. The granule is the unit of storage for the starch. Wheat starch is found in small spherical granules with diameters of 2-10 μm, or larger lens shaped granules with diameters of 20-25 μm, (Bushnuk, 1986).

In most food sources two starch molecules occur together, (1) amylose, a linear molecule with alpha-1,4 glucosidic linkages, and (2) amylopectin, a branched-chained starch molecule with alpha-1,6 glucosidic linkages. The ratio of amylose to amylopectin depends on the class and variety within a plant species. Wheat varieties average 23 to 27 percent amylose (Bushnuk, 1986; Luallen, 1988; Manners, 1985).

The structural characteristics of the starch granule are important in the breadmaking process. Shelton and D'Appolonia (1985) stated that starch dilutes the gluten to an appropriate consistency, furnishes maltose by amylase action for fermentation, provides a suitable surface for strong gluten bonding, provides flexibility for loaf expansion during partial gelatinization while baking, and sets the loaf structure by providing a rigid network to prevent dough collapse upon cooling. Three other carbohydrates found in the endosperm are pentosans (2 percent), cellulose (0.4 percent), and sugars (2 percent)(Bushnuk, 1986).

The sugars that function in dough formation are glucose, fructose, sucrose, maltose, and glucofructans. Yeast hydrolyzes dough disaccharides and oligosaccharides to fructose and glucose. Fructose and glucose are then fermented by the naturally occurring yeast enzymes which yield the gas that expands the dough structure (Shelton and D'Appolonia, 1985).

Sugars in bread dough are essential reactants in the caramelization and Maillard reactions that result in a brown bread crust. Caramelization is the distinctive brown color formed when sugars are heated to high temperatures.

Maillard browning occurs when a reducing sugar and the amine group of a protein react. The Maillard browning reaction is primarily responsible for the bread crust color. Temperature is the controlling factor in the rates of the browning reactions, therefore regulation of oven temperature is important (Shelton and D'Appolonia, 1985). The unique flavor and aroma of baked bread can be attributed to the fermentation and browning reactions.

2.10 Wheat Proteins

Common hard wheats contain 12% to 13% protein. Although wheat can provide subsistence levels of dietary proteins in reasonable quantities, they are deficient in lysine (Zapsalis and Beck, 1986).

Storage, structural, and metabolic proteins are the three classes of proteins in seed. Storage proteins provide the main nitrogen source for the germinating seed. The unique combination of amino acids that provides this efficient nitrogen storage for the seed also produces a protein low in nutritional value and high in functional properties necessary for breadmaking (Bushnuk, 1986).

Four distinct protein fractions can be separated from the wheat endosperm: albumin, globulin, gliadin, and glutenin. Three of the fractions: albumin, globulin and gliadin, have not been shown to relate directly to breadmaking quality when quality is measured by loaf volume. The amount of soluble glutenin is indirectly related to baking quality, and the amount of insoluble glutenin is directly related to baking quality (Bushnuk, 1986).

Gluten is a complex formed from the gliadin and glutenin proteins after hydration and mixing in bread dough preparation. Gluten forms a three dimensional viscoelastic network that is a unique film-forming property important for breadmaking (Haard, 1985; Inglett, 1977).

Commercially, gluten can be separated from flour to produce a dry gluten powder called vital wheat gluten. Commercial glutens are used to fortify or adjust the flour protein level for breads, rolls, buns and other yeast raised products (Magnuson, 1985; McDermott, 1985). The results of gluten fortification have been well documented and Magnuson (1985) summarized the benefits:

(1) improved dough strength, mixing tolerance, and handling properties;

(2) film forming ability provides gas retention and controlled expansion for improved volume, uniformity, and texture;

(3) thermosetting properties contribute necessary structural rigidity and bite characteristic;

(4) water absorption capacity improves baked product yield, softness, and shelf-life;

(5) natural gluten flavor enhances consumer acceptability.

The use of extracted wheat and corn gluten in research by Buck, Walker, and Watson (1987), and by Kissell and Yamazaki (1975) in yeast and non-yeast wheat flour food products indicates less desirable flavor and texture and significantly lower bread loaf volumes.

2.11 Sensory Evaluation

Sensory evaluation of food products allows a quantitative or predictive analysis of food products and qualitative evaluation can provide information on people's perceptions, feelings, and attitudes toward a product. One definition of sensory evaluation is reported by Stone and Sidel (1985), "Sensory evaluation is a scientific discipline used to evoke, measure, analyze and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch, and hearing." (p. 8). Sensory evaluation can be categorized into three types: discrimination testing, descriptive analysis, and affective testing (Stone and Sidel, 1985; Larmond, 1977).

Discrimination testing is one category of sensory testing used to determine if two products are different. Based on a particular attribute, discrimination testing can also determine direction such as which sample is sweeter in taste. Methods for determining differences are paired comparison, triangle, and dual-standard tests.

Descriptive analysis is a second category of sensory testing. Descriptive analysis identifies the sensory characteristics of one or more products and provides a profile of the products based on the presence or absence of various attributes. Quantitative Descriptive Analysis (QDA) is a quantitative sensory method that characterizes the attributes and measures the amount of the attribute. Key elements of the descriptive methods are the development of descriptive language and the use of trained panelists (Stone and Sidel, 1985; Stone, Sidel, and Bloomquist, 1980; Stone, Sidel, Oliver, Woolsey, and Singleton, 1974).

Quantitative Descriptive Analysis is a multi-product sensory test that provides a word description of a product's sensory characteristics. Panel training involves development by the panel of a descriptive language for characteristics of the products being tested and definitions for the characteristics. A scoresheet with line scale and anchor words is used in the sensory training to familiarize the panel with the QDA scoring technique. Anchor words are the descriptive language developed by the panel (Stone and Sidel, 1985; Stone, Sidel and Bloomquist 1980; Stone, Sidel, Oliver, Woolsey and Singleton 1974). The trained panel then evaluates each sample individually scoring for the amount of each attribute listed.

Affective testing is the third category of sensory testing and includes the methodologies of acceptance or preference. Discrimination testing and descriptive analysis reduce product alternatives and affective testing evaluates preference or acceptance of products by comparison of two or more products. Large scale market testing is often preceded by small scale affective testing. Paired comparison and hedonic scales are commonly used affective testing methods (Stone and Sidel, 1985; Larmond, 1977).

The central location test is also classified under affective testing and is a type of acceptance test used commonly in national and international marketing research. Consumers are brought to the test site or the test site is located strategically to large numbers of people. Central location tests require larger numbers of responses per product since there is limited control over the environment (Stone and Sidel, 1985).

2.12 Qualitative Evaluation

Patton (1982) stated that evaluation that is qualitative in design is holistic and aims at understanding phenomena through in-depth, open-ended interviewing and personal observation. The purpose of qualitative data is "to understand the point of view and experiences of other people." (Patton, 1982). In international settings, qualitative methods teamed with quantitative sensory evaluation methods provide a means to understanding the cross-cultural perspective that could otherwise be over-looked.

Open-ended responses are an elementary method of collecting qualitative data. The focus group is a nondirective group interviewing method that utilizes open-ended questions to gather qualitative information. A common application of focus group interviews is market research because producers, manufacturers, and sellers recognize the value of understanding the perceptions of consumers (Krueger, 1988).

2.13 Collaborative Development Process

In the writings of Lofquist (1983, 1989), Rogers and Shoemaker (1971), and the International Potato Center (IPC) (1982, 1983, 1985a, 1985b), three components of the development process consistently emerge: 1) the people involved, 2) the problem definition, and 3) the solution process. These components have been combined and adapted as represented in Figure 1.

2.13a The People Involved

In 1971, Rogers and Shoemaker defined participation as "the degree to which members of a social system are involved in the decision making process" (p. 286). The degree of participation at the local level is most often defined by the people managing a development project and is determined by how the managers and experts view the client. The client can be viewed as an object, a recipient, or a resource (Lofquist, 1983).

When the client is viewed as an object, the project manager and experts are in control of defining the problems and planning the solutions. The client has limited or no participation in the process. The experts solve the problem for the client and the client learns by observation of the expert. Clients must take advantage of the opportunity designed by the experts. The byproduct of this view is conformity of the client and acceptance of the program or process as it is presented (Lofquist, 1983).

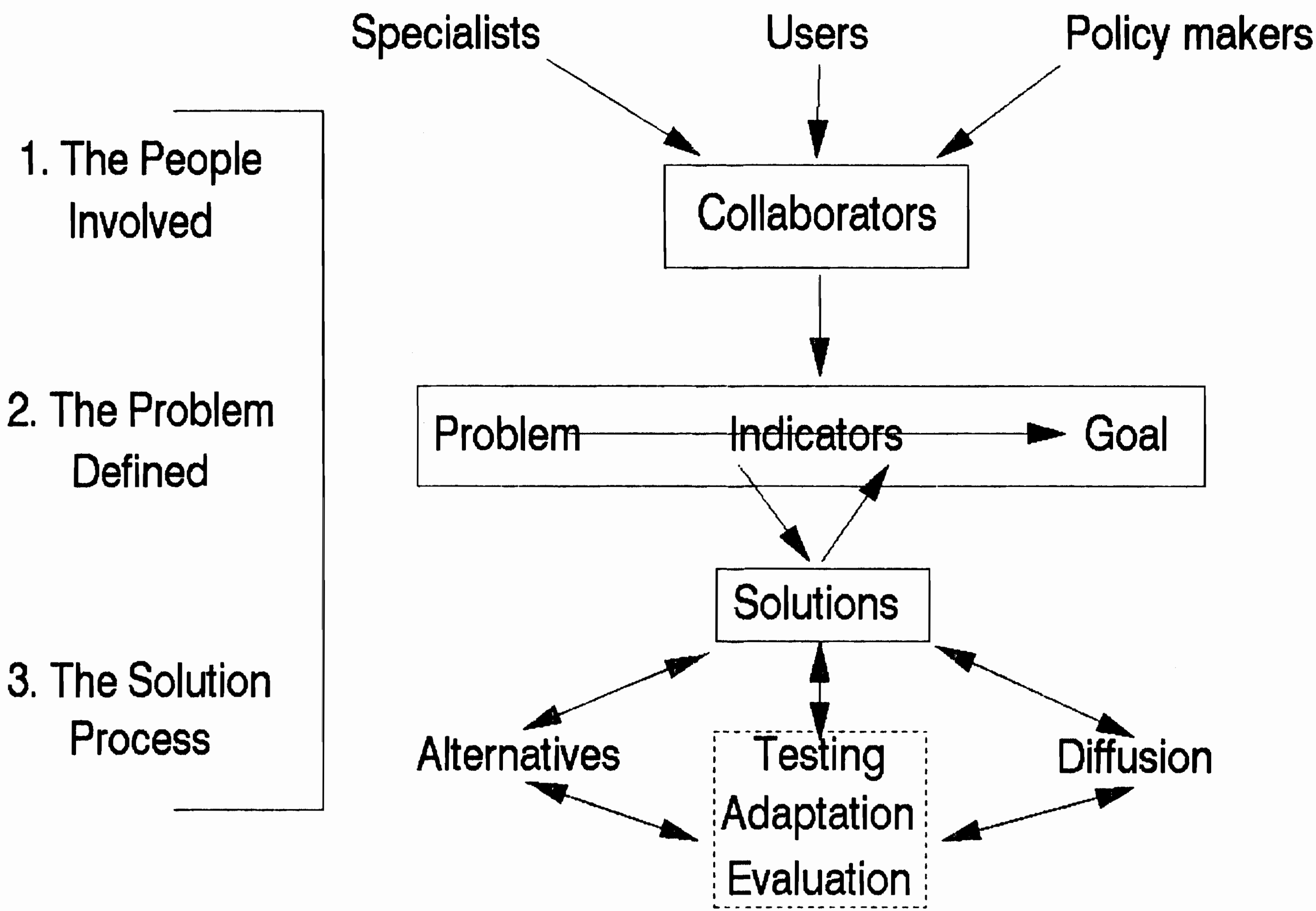


Figure 1 Collaborative Development Process

If a project manager views clients as recipients, the client is allowed to participate in a pre-determined manner in the development process. The primary emphasis is on how the client will benefit from participation in the process rather than what the client has to offer as a resource. A byproduct of this view is increased effectiveness of the development process because the degree of client participation has increased (Lofquist, 1983).

When clients are viewed as resources by project managers and experts a partnership exists that allows a collaborative development process to be designed. This view recognizes that leadership, decision-making, and resource roles are shared by all the people involved. The effectiveness of the development process is at its highest level when clients are viewed as resources. (Lofquist, 1983).

The Farmer-Back-to-Farmer model, described in the annual report of the International Potato Center (IPC, 1982), views clients as resources; "The Farmer-Back-to-Farmer" model is based on the principle that applied agricultural research and transfer of acceptable technology should begin and end with the farmer, and involve interdisciplinary teamwork in all phases of a continuous research/transfer process" (p.86). In a collaborative development process the partners (interdisciplinary team) taking part would include users from the local social system,and policy makers and specialists from local, national, or international systems.

2.13b The Problem Defined

The innovation-development process, according to Rogers (1983), starts with the recognition of a problem or need. The problem definition process involves identification of the problem, indicators, and goal.

The problem or need is, "What's happening now," or the current reality, and represents what the people involved want changed (Lofquist, 1989). The goal is the desired outcome and represents how the people involved in the development process visualize the future when the problem is solved. Indicators are markers or "pieces of evidence specifically related to a change or end result that is being sought; they are tangible and observable" (Lofquist, p. 23, 1989). Indicators are pieces of evidence that assist in: defining the problem, developing a strategy for solving the problem, and marking progress toward the goal (Lofquist, 1989; Longhurst, 1987).

When the Farmer-Back-to-Farmer model was used in the Andes, the problem definition process resulted in this statement, "Farmers look for 'friendly (potato) varieties' that offer them flexibility in use for sale as well as for household consumption" (IPC, p. 125, 1989). In this model the purpose of the problem definition process (definition, indicators, goal) was to achieve acceptable solutions for farmers' problems (IPC, 1989).

2.13c The Solution Process

Emerging from the problem definition process, specifically from the determination of indicators, is the solution process. The major components of the solution process are: 1) developing alternatives, 2) testing, adaptation and evaluation, and 3) diffusion.

The first component involves determining the potential solutions to the problem. The collaborators identify important considerations such as the needs, preferences, and concerns of the users. For example, IPC (1989) field studies in the Andes indicated that farmers rarely try to grow an "ideal" potato variety, instead they prefer a solution that allows the choice of a range of varieties that can fulfill broader needs. If the solution process is collaborative no "alternative solution" recipes, blueprints, or packages will be specified. Instead, the solutions will arise from the knowledge and previous experience contributed by specialists and policy makers, and the local knowledge and experience of the users (IPC, 1989).

The second component: testing, adaptation and evaluation is a sequence of formal and informal; laboratory and field research that compares, adapts, and evaluates potential solutions in relation to the needs of the users. IPC (1989) projects that utilize collaborative development process have combined laboratory and experiment station research with farmer experimentation. In the 1989, annual report IPC states, "Although the methods used in such experiments are not as rigorous as those in formal science, this farm-level (user) research presents clear evidence of the farmer's acute observation of the environment, of their ability to respond to changes, and of their crucial role in the process of technological change. Farmer experimentation provides both a human resource and a body of knowledge; thus, it should be stimulated to foster local adaptations of technologies and to provide insights for more formal research" (p. 126).

In a collaborative development process the decision to accept, reject, or adapt a potential solution becomes more appropriate when the users take part in reaching the decision (Rogers and Shoemaker, 1971). The user has a vantage point that is essential and unique in determining the value of a solution. The expert opinion of specialists or policy makers alone, represents just a partial view of what will make a good solution (Lofquist, 1989).

The third component of the solution process is diffusion. Diffusion is the process that communicates an idea or practice among members of a social system over a period of time (Rogers, 1983). The Farmer-Back-to-Farmer model refers to diffusion as technology "transfer" and links it directly to the testing-adaptation-evaluation sequence. Diffusion, or technology transfer, is part of a continuous solution process when collaborative development is used (IPC, 1982).

2.14 Problem Summary

In summary, the properties of potato and wheat are closely related and have the potential of substitution, one for the other. Bread, a staple food for many areas of the world, has as the main ingredient wheat flour. In those areas where wheat must be imported, potato is often widely grown and underutilized. The possibility of using potato or other tuber crops acting as a partial replacement for wheat flour offers a future of lower cost, more abundant and more secure bread supplies. The technology and collaborative development process are available for the design, testing, evaluation, and diffusion of substituted products.

CHAPTER III

MATERIALS AND METHODS

3.00 Goals and Objectives

The climate and geography of the Soviet Far East and Alaska preclude the growth of many agricultural and garden crops. Potatoes, in contrast, have been adapted to these tundra and subarctic climates and to the tundra, podzol, and mountain and valley soils of these regions (Wheeler and Kostbade, 1990). The potato varieties grown in the Soviet Far East and Alaska produce abundant crops that are utilized directly or stored in their raw form. Storage losses are often high (Vandre, 1989). The incorporation of potatoes into food products such as bread, would provide a secondary use for the potato crop and, as a partial replacement for wheat flour, could reduce the region's dependance on 'imported' commodities.

The goal of this research was to incorporate an underutilized, accessible product as a partial replacement for an imported product in a staple food such as bread and to define a collaborative process for the development of the food product in international communities. The objectives for the research were: 1) to determine the optimum replacement of wheat flour with potato products in objective and sensory laboratory tests, 2) to determine the acceptance of the breads in one Alaskan community and three communities in the Soviet Far East, and 3) to complete a descriptive sensory evaluation of the bread products' characteristics using a trained panel.

3.00a Experimental Design

The methodology for the first objective was designed to answer two questions. The first question was: Can a yeast bread formula be altered to support the incorporation of potato flakes and boiled-mashed potato? The second question was: Which potato bread products are most acceptable to consumers?

The first pilot study was designed to qualitatively evaluate the potato breads and to answer question one. Initially the American Association of Cereal Chemists (AACC) method 10-10A (AACC, 1983) bread dough formula and methodology were modified to accommodate the incorporation of potato flakes and boiled-mashed potatoes. It was later determined that the Hitachi home bakery appliance (HB-101, Compton, California) would be used for the bread dough preparation and baking, so new potato bread formulations were developed using the home bakery appliance recipes as a standard.

The bread products developed with varying levels of potato flakes and boiled-mashed potatoes were qualitatively evaluated by a group of faculty, staff, and students in the Department of Human Nutrition and Foods at Virginia Tech. Three levels of replacement of potato flakes and three levels of replacement of boiled-mashed potatoes were chosen for quantitative evaluation in the second pilot study.

The purpose of the second pilot study was to answer the second question by quantitatively evaluating the consumer acceptance of the six potato bread products. The one potato flake bread and the one boiled-mashed potato bread that scored highest in acceptability would be chosen for the central location acceptance tests in Alaska and the Soviet Far East. During the second pilot study the decision was made to have two controls, a 'rapid' bread control that was the 100% wheat flour bread recipe from the home bakery, and a 'commercial' control that was a 100% wheat flour bread purchased from a store or bakery in the community where the test was held.

The first objective was also designed to quantitatively define characteristics of the bread products and to determine if differences existed among the breads. Procedures for objective measurement of standing height, texture, moisture, protein and amino acid content, and staling characteristics were carried out in the foods laboratory at Virginia Tech.

The methodology for the second objective was designed to answer the questions, 1) which of the four breads scored in each of the central location acceptance tests do consumers find most acceptable?, and 2) are breads scored differently across locations? Three bread products were baked in the home bakery appliance and one bread product was purchased locally. Consumers in one community in Alaska and in three communities in the Soviet Far East participated in the acceptance tests. All tests were conducted in locations accessible to the general public.

The methodology for the third objective was designed to answer the questions, 1) what are the sensory characteristics that distinguish each of the bread products? and 2) are the sensory characteristics of the breads similar or different?

Quantitative Descriptive Analysis (QDA) (Stone and Sidel, 1985) was the sensory method chosen to answer the questions for this objective. Eleven panelists from Virginia Tech participated in sensory testing of five breads: 'rapid' bread (100% wheat flour bread baked in home bakery appliance), 'commercial' bread (100% wheat flour bread baked commercially), 15% replacement of wheat flour with potato flakes, 29% replacement of wheat flour with red potatoes, and 45% replacement of wheat flour with Idaho potatoes.

3.01 Bread Ingredients

3.01a Flour

Pillsbury's Best enriched, bromated, high protein bread flour (Pillsbury Co., Minneapolis, Minnesota) was chosen for use in the experimental bread formulation studies, for the Quantitative Descriptive Analysis (QDA) sensory testing, and for the physical and baking characteristics measurements. This brand of bread flour was not available in Juneau, Alaska, or in Anadyr, Magadan, and Ola, in the Soviet Far East. The flour used in Juneau, Alaska was Gold

Medal "Better for Bread", enriched, bromated, high protein flour (General Mills, Minneapolis, Minnesota). One type of unlabeled flour was available for purchase in the three communities in the Soviet Far East.

3.01b Yeast

Fleischmann's active dry yeast (7 g packages; Fleischmann's Yeast, Inc., Oakland, California) was chosen for use in all breads baked for the pilot studies, the central location testing in Alaska and the Soviet Far East, the QDA sensory testing, and the objective evaluation of bread product characteristics. Yeast packages from the same market shelf box, with the same expiration date were purchased for breads baked within the same time frame. Yeast for breads baked in Alaska and the Soviet Far East was purchased in Juneau, Alaska.

3.01c Water

Local tap water was utilized for preparation of the bread dough in all locations and for all tests and measurements.

3.01d Sugar

Domino pure cane granulated sugar (Amstar Sugar Corp., New York) was purchased for preparation of the bread in Virginia. Western Family (Western Family Foods, Inc., Portland, Oregon) pure granulated sugar was used for preparation of the bread in Alaska. Unlabeled raw (coarse) sugar was purchased locally in the three communities of the Soviet Far East.

3.01e Salt

Morton's noniodized salt and unlabeled salt were purchased for baking bread in the United States and the Soviet Far East respectively.

3.01f Fat

Fleischmann's 100% corn oil margarine (Nabisco Brands, East Hanover, New Jersey) was purchased for baking bread in Virginia and Alaska. Unlabeled butter was purchased in the Soviet Far East.

3.01g Milk

Carnation brand non-fat dry milk was purchased in Virginia and Alaska. A 476 g can of unlabeled dry milk powder was purchased in Anadyr from the dairy products store. This dry milk powder was used for baking breads in the three Soviet Far East communities.

3.01h Potatoes

Hungry Jack brand potato flakes (Pillsbury Co., Minneapolis, Minnesota) were purchased to replace wheat flour in the experimental bread formulations. This brand was used in all locations, for all tests.

Russet Burbank, Red La Soda, and Red Pontiac potatoes were purchased in Virginia and Alaska to use as a replacement for wheat flour in the experimental bread formulations. The Red La Soda and Red Pontiac have a waxy textural quality. The Russet Burbank has been described as a potato with a mealy textural quality (Vail, Phillips, Rust, Griswold and Justin, 1978). The early potato variety, Prejekulskii ranni, was used in the potato breads baked in the Soviet Far East. This variety has white skin, white flesh, waxy texture, and is ranked as 'reasonable' in cooking quality (Carling, 1991; Appendix 3.01h[i]).The preparation method for the boiled potatoes is described in Appendix 3.01h(ii).

3.01i Vital Wheat Gluten

Vital wheat gluten, in a free-flowing powder form (Watson Foods Co., Inc., Boston, Mass.) was added to half of the pilot study bread formulations and to the 15% potato flake experimental bread that was field tested. The level added ranged from 2% to 3% on a flour basis.

In the baking industry, vital wheat gluten's visco-elastic properties improve dough strength, mixing tolerance and handling properties (Appendix 3.01i, Raw Material Specification). Vital wheat gluten is commonly used in hard rolls and multigrain, and other high fiber or specialty breads at levels of 2% to 10%. Vital wheat gluten is approved by the U.S. Food and Drug Administration as 'Generally Recognized as Safe' (GRAS) under 21 C.F.R. #184.1322, for use as a dough strengthener, formulation aid, nutrient supplement, processing aid, stabilizer and thickener, surface finishing agent, and texturizing agent at levels not to exceed good manufacturing practice. Vital wheat gluten also meets requirements for purity stipulated by the joint FAO/WHO Expert Committee on Food Additives (International Wheat Gluten Assoc., Prairie Village, Kansas).

3.01j Measuring Techniques

Weight measurement of the ingredients on a gram scale was not possible in the sensory field tests in Alaska and the Soviet Far East. Volume measurement of the ingredients was the method chosen. Metric measuring cups and spoons and the Hitachi home bakery measuring spoon were the utensils used in the field. The accuracy of volume measurement was controlled by measuring, then weighing, in several trials, until the weight of each volume measurement was consistent in at least three trials (Appendix, 3.01j).

3.01k Mixing Method in Home Bakery Appliance

For all recipes, the water was measured first and poured into the bread pan. Then, in a mixing bowl the flour and potato flakes or boiled-mashed potatoes were mixed thoroughly. The potato flakes and flour were stirred and lightly tossed 50 times with a fork. The boiled-mashed potatoes were cut into the flour with a fork until the mixture was uniform in texture. The remaining dry ingredients were added to the flour-potato mixtures and lightly tossed an additional 50 times, then added to the water in the bread pan. The margarine or butter was measured and placed on top of the flour mixture. The yeast was measured and added last.

3.02 Appliance: Hitachi Home Bakery

The Hitachi Home Bakery appliance HB-B101 (National Headquarters: Compton, California), was purchased for the dough preparation and baking of: 1) all the pilot breads, 2) breads baked for the central location acceptance testing by consumers in Juneau, Alaska and in Anadyr, Magadan, and Ola, USSR, 3) breads evaluated by QDA, and 4) breads prepared for the objective measurements. A bread baking appliance was selected for preparation of the breads to minimize variations in bread products baked in four locations, in two countries, under fluctuating conditions, including different power supplies. The 'rapid bread' setting, requiring 2 hours and 50 minutes for preparation of the bread was chosen for all field and lab work.

3.02a Framework of Analysis for the Home Bakery System

The purpose of a bread baking appliance system is to provide a source of energy for the preparation and baking of bread dough. The actions performed by the appliance to achieve that purpose are: mixing, kneading, resting, heating, and cooling.

3.02b Summary of Appliance Structure, Components, and Operation (Hitachi Service Manual)

A detachable, non-stick, plastic coated bread pan is mounted inside, in the center of the appliance. Projecting from the bottom center of the bread pan is a rotary shaft which is attached to a detachable mixing blade. A bearing assembly is located under the bread pan and is mounted on the chassis. A lever on the bearing assembly turns on a microswitch when the bread pan is mounted on the bearing assembly, or it turns off the microswitch when the bread pan is removed. The mixing motor is mounted on the chassis on the front side, its driving power is transmitted to the mixing blade inside the bread pan via a pulley and belt. A steel case forms a jacket around the bread pan and becomes the heating chamber. A heating element extends across the bottom of the heating chamber. A ceramic thermal fuse designed to melt at 192 degree C (378 degree F) will indicate a malfunction in the heating element. Hot or warm air is circulated in the heating chamber by a fan driven by a fan motor. A bread pan temperature sensor maintains contact with the bottom of the bread pan and senses the temperature of the dough in the pan. During dough preparation and baking the temperature ranges from 28 degrees C (82.4 degree F) during the mix cycle, to 160 degrees C (320 degrees F) during the bake cycle. At the completion of the bake cycle the finish cycle cools the bread to a suitable temperature.

The heater, main motor, and fan motor are controlled by the temperature sensor output and a microcomputer in the control panel on the top front of the bakery appliance. The main motor is supplied with direct current and has a built-in alternating current to direct current converter. The Hitachi Automatic Home Bakery, household type, uses a power supply of 680 watts, 120 volts (alternating current), and 60 Hertz.

3.02c User Interaction with the Appliance System

The user interacts with the appliance at these points in the bread making process:

1. Removing the bread pan and installing the mixing blade.
2. Measuring the ingredients into the bread pan.
3. Placing the bread pan into the bread maker and closing the lid.
4. Plugging the bread maker into a power supply.
5. Making appropriate selections from the control panel.
6. Removing the bread pan from the appliance and the dough or bread from the pan at the completion of the dough preparation or baking.

3.02d Equipment: Transformer

A Magnetech Jefferson Electric stepdown transformer (.750 KVA, 50/60 Hz., high volt 240/480, low volt 120/240) was purchased from Grainger Industrial and Commercial Equipment and Supply Company, Roanoke, Virginia. The transformer stepped down the 240 volt power supply in the Soviet Far East to the

120 volts needed by the appliance. The bakery appliance was plugged into the transformer and the transformer into the power source (Appendix, 3.02d).

3.03 Pilot Studies

3.03a Pilot Study One

The first pilot study provided qualitative observational data on the feasibility of altering a white bread formula by replacing varying amounts of wheat flour with potato flakes or baked potato, with or without added vital wheat gluten. The AACC-10-10A bread dough formula and methodology were initially used for the experimental bread formulations. When the decision was made to purchase the automatic home bakery appliance the bread formulations were reevaluated for use with the home bakery appliance. All experimental breads for pilot study 2 were baked in the home bakery appliance.

3.03b Pilot Study Two

The second pilot study measured the acceptance of three replacement levels (9%, 15%, and 21%) of wheat flour with potato flakes; each replacement level was evaluated with and without added vital wheat gluten. Three replacement levels (29%, 45%, and 54%) of wheat flour with boiled mashed potato were also evaluated with and without added vital wheat gluten. Gluten was added as a dough strengthener at the 2% (flour basis) level.

Four bread samples were placed on each plate. Each bread sample was wrapped in a plastic sandwich bag and coded with a colored dot. When scoring the breads, panelists were asked to match the colored dots found on the bread samples with the corresponding dots on the scoresheet.

A scoresheet with an unstructured line scale 15 centimeters in length with anchor words of "like very much" and "dislike very much" was presented with instructions to 60 student, faculty and staff panelists in the College of Human Resources, Virginia Polytechnic Institute and State University (Appendix, 3.03b[i]). Each panelist scored four bread samples and each bread sample was scored 20 times. The six variations of potato flake breads and the six variations of boiled-mashed potato breads were tested on separate days. The data were statistically evaluated by the analysis of variance method and the experimental breads were chosen for field testing based on their level of acceptance.

Written and oral comments made by panelists, especially those participating in sensory evaluation for the first time, indicated that some panelists found the unstructured line scale difficult to understand and use in scoring the breads. Since untrained, inexperienced panelists would be scoring the breads in Alaska and the Soviet Far East, a decision was made to evaluate two structured seven point hedonic scales. The anchor words, "dislike" and "like" were retained (Appendix, 3.03b(ii)).

Twelve faculty and staff from the Department of Human Nutrition and Foods at Virginia Polytechnic Institute and State University scored bread samples using the two scales and were asked, "If you were taste testing for the first time, which line scale would be easier to understand and to use?" The decision to use a seven point ascending hedonic scale with anchor words, was based on this evaluation and on information indicating that Soviet citizens are familiar with an ascending hedonic scale. Intermediate descriptors for each point on the scale were not used. Translation of the descriptors into Russian was difficult. The modified scoresheet combined features from hedonic and semantic differentiation scales. The scoresheet was translated into Russian by Dr. Anglia Graf of the Language Department, Virginia Tech (Appendices, 3.03b(iii), 3.03b(iv)).

Hedonic scales in acceptance testing of food products yield "degree of liking" information about the products tested. Acceptance tests do not explain why one product is liked more or less than another. In the cross-cultural settings found in Alaska and the Soviet Far East the need to collect qualitative data that might assist in explaining the acceptance test results was important. A questionnaire was developed (Appendix, 3.03b(v)) that was designed to retrieve qualitative information about the choices individual consumers made on the acceptance test of the bread products. The questionnaire was developed in collaboration with Dr. Michael Lambur, Extension Specialist-Evaluation, Virginia Tech. The questionnaire was to be administered to every third individual participating in the acceptance test. In Juneau, Alaska the interview schedule was carried out in the manner described. In the three communities in the Soviet

Far East the answers to the interview questions generally reflected consensus statements of more than one person.

3.04 Objective Evaluation of Bread Products

3.04a Volume

An index to bread volume was the measurement of standing height (Penfield and Campbell, 1990). The standing height of the bread was measured approximately 24 hours after baking. Loaves of bread were cut in half lengthwise, using the indentations left by the home bakery appliance bread pan as markers. Breads were placed on a flat surface and standing height was measured with a metric ruler, at three locations on each cut surface of each half loaf. The standing height was measured on loaves baked on three separate days. The data were statistically analyzed by the general linear model, analysis of variance method using Number Cruncher Statistical System software.

3.04b Cell Size

Cell size of the baked bread products was examined by photocopying bread slices, according to the methodology outlined by Conforti (1989). A center slice of bread, approximately 10 mm in thickness, was used for photocopying. The bread was cut approximately 24 hours after baking.

A Savin (model 7350) copier, set at high contrast, darker copy, number two was used.

3.04c Moisture

The percent moisture loss of bread samples was measured according to methodology outlined in Brabender Moisture Tester (South Hackensack, New Jersey) manual. The Brabender Moisture testing equipment was calibrated prior to each test. Two 10 gram samples of fine bread crumbs were weighed, placed into pans, and placed in the preheated Brabender Moisture Tester. The two hour total drying and recording time to a constant weight at 155 degree C. (311 degrees F) for the bread samples had previously been determined. Percent moisture loss readings were taken directly from the Brabender Moisture Tester. Four readings were taken at 15 minute intervals during the second hour of drying. The measurements were taken at day 1, day 2, and day 4. Repeated measures analysis of variance methodology was chosen for analysis of the data using the Number Cruncher Statistical Systems software (Hintze, 1987).

3.04d Protein (Crude Protein) and Amino Acid Content

The crude protein content of the flours used and of five bread products were analyzed by Kjeldahl nitrogen analysis (Buchi distillation and control units, Switzerland). The three flours evaluated were, Gold Medal, Pillsbury, and Soviet. The five bread products measured were, 100% Pillsbury wheat flour, 100% Soviet wheat flour, 15% replacement of wheat flour with potato flakes with added gluten, 29% replacement of wheat flour with boiled-mashed red potatoes, 45% replacement of wheat flour with boiled-mashed Idaho potatoes was analyzed by

Kjeldahl nitrogen analysis. A constant relationship between total nitrogen and the amino acid polymers that link to form the protein complex is assumed and is reflected in the calculation of protein content by multiplying the total nitrogen by 5.70 (constant factor used for wheat, flour, and bread products) (AACC 46-12, 1983).

Amino acid analysis of the Soviet and Pillsbury flours and the three experimental breads was conducted by the Animal Science Laboratory at Virginia Tech. An Amino Acid Analyzer (Water Pico-Tag, Millford, Massachusetts) was used according to the instruction manual. A hydrolysate procedure for freeze dried samples and derivitization procedure proceeded the amino acid analysis.

The Number Cruncher Statistical Systems (Hintze, 1987) descriptive statistical analysis method was used to evaluate the protein and amino acid content of the flours and breads.

3.04e Analysis of Freshness

The Stevens-LFRA Texture Analyzer (Model TA-1000; Scarsdale, N.Y.) was the equipment used for the analysis of freshness. The measurements tested for springback or resiliency of the bread. The methodology followed was outlined in the reference manual of the texture analyzer, except for one modification discussed below.

The grams of force required to lower a probe a specified distance, at a specified speed, into a bread sample were measured. The cycle mode allowed multiple compressions of the bread sample during each test session. The method outlined in the Stevens-LFRA manual was modified by testing the bread samples for eight days rather than for two days. Day 0, was the day the bread was baked, these initial measurements were taken after the bread had cooled for two hours.

The second slice from the center of the bread loaf was removed and the thickness was measured. A thickness of 10 mm +/-2 mm was the standard. A 4 cm wide, center section of the bread slice was used for the analysis of freshness test. A 2.5 cm diameter probe (TA-11) was attached to the analyzer. The probe depth was set at 5 mm and the speed of penetration was 2 mm/second. The mode switch was set to "cycle" and the bread sample was subjected to twelve probe penetrations per test. The bread samples were wrapped tightly in plastic wrap and retested on days 1, 2, 3, 4, 5, 6, and 7. Measurements were not replicated for each type of bread.

Descriptive analysis of the data was run on Number Cruncher Statistical Systems software and the mean grams of force measurements plotted over eight days for each bread tested.

3.04f Bread Staling Measurements

Differential Scanning Calorimetry measures the amount of heat required to break the bonds between hydroxyl groups of closely associated amylose chains. As bread retrogrades, or stales, the number of hydroxyl cross bonds increases and the amount of heat required to break the bonds increases. The results are expressed as DSC thermograms, which are a plot of specific thermal capacity (mcal/second, Y axis) versus temperature (degrees C., X axis) (Russell, 1983). Retrogradation and therefore staling, will progress in relation to time, so DSC thermograms are evaluated over intervals of time.

A bread baking and DSC schedule was designed for a three week period. Two baking periods that allowed a 24 hour time period between the completion of baking and the first DSC run were established. Bread loaves remained unsliced and were wrapped in plastic wrap then enclosed in a shelf-closing, storage plastic bags. All loaves were stored at room temperature. The time intervals for DSC thermograms in this study were day 0, day 2, day 4, day 6, day 8, day 10, day 12, and day 14.

The equipment used in this study included: DSC and system controller (Perkin-Elmer, System-4, Norwalk, Connecticut), computerized micro-balance (Perkin-Elmer AD-6), stainless steel capsules and capsule crimper (Perkin-Elmer). TADS, the DSC standard program was used. The program parameters were modified to the following conditions:

1. Temperature final = 140 degrees C,
2. Temperature minimum = 15 degrees C,
3. Temperature increments = 15 degrees C,
4. Temperature initial = 15 degrees C,
5. Y range = 5,

6. Heating rate = 10 degrees C/minute,

7. Cooling rate = 320,

8. Sample weight = modified for each sample,

9. Plot = Normal

10. S.A.Z. = Normal

The DSC was calibrated with an indium standard. The reference was a sealed empty aluminum pan placed in the compartment to the right of the sample pan compartment.

Bread samples of approximately 50 mg were weighed on the computerized micro-balance. The samples were encapsulated in stainless steel pans with lids that were crimped into position. The sample pan was loaded into the sample compartment and the DSC program was started. At the end of the run thermograms were plotted and printed out for each bread sample for each day.

3.05 Quantitative Descriptive Analysis (QDA)

Quantitative Descriptive Analysis (QDA) is a test method that results in a quantitative description of a product's sensory characteristics. QDA relies on trained panelists to make relative judgements about the sensory characteristics of more than one product in a controlled environment (Stone and Sidel, 1985).

3.05a Panel Selection

Panelist selection was based upon an individual's interest, willingness to participate in three hours of training, availability for training and three panel sessions, and use of bread products. Eleven panelists were chosen from the undergraduate and graduate student population of the Departments of Human Nutrition and Foods, Food Science and Technology, and Housing, Interior Design and Resource Management at Virginia Tech. Nine panelists were experienced in sensory evaluation methods, including QDA. Two panelists had never participated in a sensory panel.

3.05b Panel Training

The eleven member panel met for one, two hour training session and one, one hour training session. The objectives of the sessions were: 1) to reach consensus on the bread characteristics that would be evaluated, 2) to define anchor words for each characteristic, and 3) to become familiar with the defined characteristics and the scoresheet by sampling four bread products.

At the first training session the author acted as a nonparticipatory panel leader, while panelists worked together to develop the sensory language, anchor words and definitions for the bread products (Stone and Sidel, 1985). To facilitate the development of the sensory language, bread was purchased from a local bakery for panelists to sample. Panelists identified ten bread characteristics, and defined each characteristic and its accompanying anchor words. The panel leader assisted in writing a reference sheet for the sensory language definitions that was available to panelists during the second training session and the three test sessions (Appendix, 3.05b[i]).

The second training session allowed panelists to refine the sensory language and definitions and to practice using the scoresheet and reference sheet while sampling four different breads. Panelists were encouraged to discuss the sensory language and definitions and to ask for clarifications while sampling the breads. Panelists determined a need to sip water between samples at the training session. The final reference sheet and score sheet are shown in the Appendices 3.05b(i) and 3.05b(ii).

3.05c Bread Products Evaluated

The five bread products evaluated by QDA were, 15% replacement of wheat flour with potato flakes with added gluten, 29% replacement of wheat flour with boiled-mashed red potatoes, 45% replacement of wheat flour with boiled-mashed Idaho potatoes, 100% wheat flour bread baked in the home bakery appliance, and 100% wheat flour bread purchased from a local commercial bakery.

3.05d Sample Preparation

The 15% potato flake bread, 29% boiled-mashed red potato bread, 45% boiled-mashed Idaho potato bread, and 100% wheat flour bread were baked in the Hitachi home bakery appliance the day prior to the QDA testing. The 100% wheat flour bread purchased from the local bakery was baked the day prior to the QDA testing.

Bread slices of 10 mm thickness were obtained by cutting all loaves in a bread frame designed for the size and shape of loaf produced in the home bakery appliance. Six slices from the middle of each loaf were cut in half from top to bottom; each panelist received half a slice of bread as a sample. Each sample was wrapped in a plastic sandwich bag and coded with a different colored dot. The code corresponding to each type of bread was randomly chosen for each of the three test sessions.

3.05e Sensory Testing Environment

The five breads were evaluated by eleven panelists on each of three days. Panelists tasted the bread samples in the sensory lab booths under cool white fluorescent light. Each panelist received five samples of bread on a white paper plate. All panelists were requested to sip water between bread samples. The plate, scoresheet, reference sheet, pencil, water, and napkin were arranged on a tray for each panelist.

3.05f Statistical Analysis

The purpose of the statistical analysis of the QDA scores was to compare the level of each of the ten characteristics, among the five breads evaluated. The

Friedman Block test was used to test differences among treatment means when treatments and blocks are used in the experimental design (Hintze, 1987). For the Friedman Block test the response variable was the score given each characteristic, the treatments were the five types of bread, and the block was on subjects. The scores for each characteristic were compared for the five types of bread. The data was analyzed using Number Cruncher Statistical System software. The Bonferroni multiple comparison procedure was applied to mean ranks of scores where evidence of significant differences existed (Pedhazur, 1982).

3.06 Consumer Acceptance Testing and Qualitative Evaluation of Bread Products in the USSR and USA

In 1989, a potential joint research project involving potato bread products was identified during a research exchange sponsored by the University of Alaska's Institute for Circumpolar Health in Anchorage and the USSR Institute for Biological Problems of the North in Magadan. In 1990, a return invitation of one month was extended by the USSR Institute for Biological Problems of the North in Magadan to carry out the sensory evaluation of bread products in the communities of Anadyr, Magadan, and Ola in the Soviet Far East. Dr. V. Fisher of the University of Alaska-Anchorage, Office of Soviet Relations coordinated the research exchange.

3.06a Consumer Acceptance Testing in Central Locations

Acceptance testing measures the degree of "liking" of a product on a hedonic scale. Consumer testing targets population groups for whom the products being tested are intended. Central location testing or field testing, brings the products being tested to the targeted population groups (Stone and Sidel, 1985). Three communities in the Soviet Far East and one community in Alaska were identified as the central locations for consumer acceptance testing of bread products during the summer of 1990.

3.06b Community 1: Juneau, Alaska (Appendix, 3.06b[i])

Coordination: The University of Alaska, Cooperative Extension Home Economist, Ms Sally R. Pate, in Juneau, Alaska facilitated the central location testing of the bread products in Juneau, Alaska.

Bread Products: Two experimental breads, 15% replacement of wheat flour with potato flakes with added gluten, and 45% replacement of wheat flour with boiled-mashed potato plus two control breads, 100% wheat flour bread baked in the home bakery appliance, and a commercially purchased 100% wheat flour bread were evaluated (Appendix, 3.06b(ii)). Breads were baked the day prior to the testing. Home Pride, 100% wheat flour bread was purchased the day prior to the acceptance testing. All samples were cut, wrapped, and coded immediately before the acceptance testing began.

Location: The Food Land supermarket in Juneau, Alaska was the central location chosen for the acceptance testing of bread products on Friday, July 20 from 3 pm to 6 pm (Appendix, 3.06b(iii)). Two tables and chairs were arranged in the enclosed entry to the market.

Consumers: Consumers for the acceptance testing were solicited as they entered or exited the supermarket. Posters and a flyer identified the research sponsors and briefly explained the purpose of the consumer acceptance testing. Forty consumers participated in the acceptance testing. Twelve consumers answered interview questions concerning the choices they indicated on the scoresheet for the acceptance test.

3.06c Community 2: Anadyr, USSR (Appendix, 3.06b(i))

Coordination: Ms Natasha Balmysheva, a scientist from the Human Genetics Lab of the Institute of Biological Problems of the North acted as interpreter and coordinator of the central location acceptance tests in the USSR. In each community she worked with local representatives of the Institute, local officials, and local citizens to identify a time and site for the acceptance test.

Bread Products: The experimental bread with 45% replacement of wheat flour with boiled-mashed potato failed to produce a bread dough. The potatoes were recently harvested and purchased from the local restaurant. The variety of potato available in Anadyr was high in moisture content, low in dry matter or complex carbohydrate, and low in simple sugars (Carling, 1991). The sugar and moisture content of the potatoes would be a function of the variety, growing conditions, and the age of the potatoes. The bread recipe was reformulated to accommodate the potato variety locally available. A recipe with 29% replacement of wheat flour with boiled-mashed potatoes, increased sugar, increased dry yeast, and decreased water was tested and utilized in the acceptance tests in the USSR (Appendix, 3.06b[ii]).

In Anadyr, the two experimental breads were the 15% replacement of wheat flour with potato flakes with added gluten, and the 29% replacement of wheat flour with boiled-mashed potato plus two control breads, 100% wheat flour bread baked in the home bakery appliance, and a locally purchased, unlabeled bread. Breads were baked the day prior to the testing. All samples were cut, wrapped, and coded immediately prior to the acceptance testing.

Location: The Anadyr state-owned restaurant located at the local hotel was the site for the acceptance testing, on Friday, July 27, 1990 (Appendix, 3.06c(i)). The plates with the bread samples were laid out on the tables. A decision was made to serve hot tea during the acceptance test; a Soviet modification that was kept constant in all subsequent tests.

Consumers: Consumers for the acceptance testing included local officials, restaurant staff, hotel guests, and local citizens. Participants originated from Anadyr, other communities surrounding Anadyr, and at least one other republic. Twenty consumers participated in the Anadyr acceptance test. Individuals or groups came into the restaurant, were invited to find a seat and then given instructions and information concerning the test by Natasha Balmysheva. Natasha also interviewed individuals or groups and wrote down their comments about the bread products. Six survey questionnaires were completed. There was a high level of interaction among participants sitting at the same table.

3.06d Community 3: Magadan, USSR (Appendix, 3.06b(i))

Coordination: Ms Natasha Balmysheva, Dr. Leonid Solovenchuk, and Dr. Andre Lapinski of the Human Genetics Lab, Institute of Biological Problems of the North facilitated the central location testing of bread products at the Institute in Magadan.

Bread Products: Two experimental breads, 15% replacement of wheat flour with potato flakes with added gluten, and 29% replacement of wheat flour with boiled-mashed potato, plus two control breads, 100% wheat flour bread baked in the home bakery appliance, and a locally purchased, unlabeled bread were evaluated. Breads were baked the day prior to the testing. All samples were cut, wrapped, and coded immediately before the acceptance testing began.

Location: The conference room of the Institute of Biological Problems of the North in Magadan was the central location chosen for the acceptance testing of bread on Tuesday, July 31, 1990, from 2 pm to 4 pm (Appendix, 3.06d(i)). The plates with the bread samples were placed on a large conference table along with samovars for the preparation of tea.

Consumers: Consumers for the central location acceptance testing included employees of the Institute of Biological Problems of the North. Forty consumers participated in the Magadan acceptance testing. Participants came to the table and were given the bread samples, scoresheet, and tea and then found a seat in the auditorium. General directions were given to the group and questions were answered on an individual basis. Interaction among participants in the room was high. Natasha Balmysheva and Andre Lapinski interviewed 13 participants after they had scored the bread samples. Those individuals requested to answer the interview questions discussed the answers extensively with others.

3.06e Community 4: Ola, USSR (Appendix, 3.06b(i))

Coordination: Natasha Balmysheva and Leonid Solovenchuk coordinated the central location testing at the regional hospital in Ola. The hospital administrator and staff assisted in determining a location and recruiting volunteers for the acceptance testing.

Bread Products: Two experimental breads, 15% replacement of wheat flour with potato flakes with added gluten, and 29% replacement of wheat flour with boiled-mashed potato, plus two control breads, 100% wheat flour bread baked in the home bakery appliance, and a locally purchased, unlabeled bread were evaluated. Breads were baked the day prior to the testing. All samples were cut, wrapped, and coded immediately before the acceptance testing began.

Location: The regional hospital at Ola was the site for the final acceptance testing on Monday, August 6, 1990, from 2 pm to 4 pm (Appendix, 3.06e(i)). The plates with the bread samples were laid out on tables. Tea was prepared and served from the hospital kitchen.

Consumers: Consumers participating in the acceptance testing included patients and staff of the hospital. Participants represented various communities located in the region around Ola. Twenty-two consumers participated in the Ola acceptance tests. Individuals came into the dining area, were invited to find a seat and then were given instructions and information concerning the test by Natasha Balmysheva. Natasha interviewed individuals and wrote down their comments about the bread products. Six survey questionnaires were completed. There was some interaction among participants but it was less than had been observed in the other two locations.

3.06f Statistical Analysis

Data from the central location consumer acceptance testing of the four breads in Juneau, Alaska and in Anadyr, Magadan, and Ola, USSR were statistically analyzed by individual bread across locations and by individual location across breads.

The Kruskal-Wallis test is a nonparametric analog of the parametric oneway analysis of variance F-test. It is used to test the difference among two or more group means (Hintze, 1987). In the Kruskal-Wallis test the response variable was identified as one of the four bread types and the group variable was identified as location. The acceptance scores were evaluated by bread type and compared across the four locations. The Bonferroni multiple comparison procedure was applied to results where evidence of significance differences existed (Pedhazur, 1982).

The Friedman Block test is a nonparametric analog of the parametric two way randomized complete block analysis of variance F-test. This test is used to test differences among treatment means when treatments and blocks are used in the experimental design (Hintze, 1987). For the Friedman Block test the response variable was the acceptance scores, the treatments were the four types of bread, and the block was on subjects. The acceptance scores for the four breads were compared at each location. The data was analyzed using Number Cruncher Statistical System software. The Bonferroni multiple comparison procedure was applied to mean ranks of scores where evidence of significant differences existed (Pedhazur, 1982).

CHAPTER IV

RESULTS AND DISCUSSION

4.00 The Problem and Its Environment

The Soviet Far East and the State of Alaska have in common: geographic location and size, soils, climate, extremes in distances from major national urban and governing communities, and populations that are transient and a mixture of ethnic and cultural backgrounds. These two regions are unique in national cultural and historical perspectives and in their forms of government. The regional similarities seem to give rise to a set of problems that are inherent. How those problems are perceived, and the resources available to solve the problems are defined by those aspects unique to each region.

In the regions of the Soviet Far East and Alaska, the conditions exist for abundant harvest and utilization of potatoes. In Alaska, a major harvest does not occur because the problems of handling, distribution, and storage or processing of the crop have not been solved. In the Soviet Far East the potato crop is abundant, and could be expanded, because the demand is high. According to Soviet agricultural scientists (Magadan, 1991) handling, distribution, and storage of the potato crop are also a problem in this region, with significant post harvest losses occurring. In both regions, intervention at the storage and processing stage by incorporating the raw product into another food item, such as bread, or through secondary processing into food products such as potato flakes would allow expansion of the harvest and/or a decrease in post harvest losses.

In these remote regions most foods and ingredients must be transported to the communities by plane or barge from Republics or States that have climates and soils more conducive to agriculture. The costs for transport are high and in Alaska this cost is reflected in the cost of the food to consumers. In the Soviet Far East the government bears the cost through subsidies that keep the costs to consumers at a low level.

Breads made from potato products as a partial substitute for wheat flour were used as a model to test the feasibility of substituting a locally available food product for an imported ingredient. Further, a requirement of the local product was that it be incorporated with limited preparation or processing since the technical facilities for further processing may not be available.

4.01 Development of the Experimental Breads

The formulas, score sheets, and methodology for the central location acceptance testing of the experimental breads were developed during the two pilot studies.

4.01a Pilot Study One

The objective of the first pilot study was to determine the feasibility of altering a 100% wheat bread formula by replacing varying amounts of wheat flour with potato flakes or boiled-mashed potato, with or without added gluten. Gluten gives structure to bread and is not present in potatoes. Gluten was added to the experimental breads as a dough strengthener to offset the loss of gluten in the replaced wheat flour. The products were evaluated by faculty, staff, and students in the Department of Human Nutrition and Foods at Virginia Tech, Blacksburg, Virginia. Subjective evaluation of the products included overall appearance, external and internal color, texture, and taste.

Panelists discussed the products and reached a consensus on the products to be accepted or rejected for further study. The discussions indicated that twelve products would be acceptable for quantitative evaluation in the second pilot study. The breads chosen were: 29%, 45%, and 54% replacement of wheat flour with boiled-mashed potatoes, with and without added gluten, and 9%, 15%, and 21% replacement of wheat flour with potato flakes, with and without added gluten.

The first pilot study was designed to test the feasibility of altering 100% wheat bread formula to allow incorporation of potato products. This initial step was the foundation for evaluating the potential of utilizing an abundant, locally grown potato crop in bread products which are rationed in the Soviet Far East and must be imported in the state of Alaska. The results of the first pilot study indicated that structurally, potato flakes and boiled-mashed (Idaho) potatoes could be incorporated into bread products at levels to 54% with boiled-mashed (Idaho) potatoes and to levels of 21% with potato flakes. All variations were subjectively evaluated with and without added vital wheat gluten. The gluten was added at the 2% level as a dough strengthener, in an attempt to offset the loss of gluten when the potato products replaced the flour.

4.01b Pilot Study Two

The objective of the second pilot study was to measure the sensory acceptance of the twelve experimental breads developed in the first pilot study. The results would determine the bread products chosen for the central location acceptance tests.

Sixty students, faculty, and staff participated in two acceptance tests of the experimental breads. The breads were scored on an unstructured 15 cm line scale with a score of 0 represented by the anchor "like very much" and a score of 15 represented by the anchor "dislike very much". The results of the acceptance tests are shown in Tables 1 and 2.

A general linear model, analysis of variance procedure from the Number Cruncher Statistical System software program was used to evaluate the data. At a 95% confidence level ($p < .05$), there was not adequate evidence to indicate significant differences existed among the six levels of boiled-mashed potato breads or among the six levels of potato flake breads. The mean scores for the

Table 1 Pilot Study 2: mean acceptance scores of six experimental boiled-mashed potato yeast breads (Idaho potato) with and without added gluten (1,2)

	Mean Score	Standard Error
EXPERIMENTAL BREADS		
29% Idaho Potato	5.77a	0.63
29% Idaho Potato	4.55a	0.63
(with added gluten)		
45% Idaho Potato	4.47a	0.63
45% Idaho Potato	4.75a	0.63
(with added gluten)		
54% Idaho Potato	5.08a	0.63
54% Idaho Potato	5.27a	0.63
(with added gluten)		

1. Scores:0=like very much;15=dislike very much.
2. a Means in columns with unlike codes are different ($p < .05$).

Table 2 Pilot Study 2: mean acceptance scores of six experimental potato flake yeast breads with and without added gluten (1,2)

	Mean Score	Standard Error
EXPERIMENTAL BREADS		
9% Potato Flake	4.70a	0.62
9% Potato Flake	4.19a	0.62
(with added gluten)		
15% Potato Flake	3.87a	0.62
15% Potato Flake	4.07a	0.62
(with added gluten)		
21% Potato Flake	6.02a	0.62
21% Potato Flake	4.53a	0.62
(with added gluten)		

1. Scores:0=like very much;15=dislike very much.
2. a Means in columns with unlike codes are different ($p < .05$).

boiled-mashed potato breads ranged from 4.47 to 5.77. Scores in this range would suggest that panelists "liked" the bread products. The mean scores for the potato flake breads ranged from 3.87 to 6.02. Scores in this range would suggest that panelists "liked" the breads, although the score of 6.02 for the 21% potato flake bread without added gluten would suggest that panelists felt "neutral" about this product, neither liking nor disliking it. The mean acceptance scores document that panelists did not find breads with added gluten more or less acceptable than breads without added gluten.

The second pilot study measured the sensory acceptance of the six variations of boiled-mashed potato bread (29%, 45%, and 54%, all with and without added gluten) and the six variations of potato flake bread (9%, 15% and 21%, with and without added gluten).

The results did not assist in choosing specific bread products for the central location acceptance testing. Although all the scoring of the bread products indicated that panelists liked the breads, there was no significant difference in the degree of liking. Panelists judged the bread variations with added gluten as similar in acceptability to the breads without added gluten. The results do not agree with research by Harris (1932), Jain and Sherman (1974), and Kissell and Yamazaki (1975) whose results indicate the maximum level of replacement of wheat flour with cooked potato products ranges between 10% and 20%. Authors of earlier research on potato breads may have obtained different results based on methods of evaluating bread quality. Sensory evaluation methods of bread quality were less objective in these studies. In 1974, research by Jain and Sherman evaluated the partial replacement of wheat flour by potato flakes. Using the Chorleywood Process the authors were successful in replacing 20% to 30% of the wheat flour with potato flakes. The 21% level of replacement with potato flakes was the maximum level achieved using the Hitachi home bakery appliance. Higher levels of replacement resulted in compact loaves that were extremely adhesive in texture.

The experimental breads chosen for central location acceptance testing were the 45% boiled-mashed (Idaho) potato bread without added gluten, and the 15% potato flake bread with added gluten. The mean acceptance scores for these two breads were lowest, or closest to the "like very much" anchor on the unstructured scale.

4.02 Objective Evaluation of Bread Products

4.02a Volume

Standing height was the measurement selected as an index to volume. The mean measurements for standing heights are recorded in Table 3. The statistical analysis indicated no significant differences among the five bread products. Harris (1932) reported an increase in volume up to a replacement of 20% potato, with a decrease beginning at 40% replacement of potato for flour. Harris' results do not agree with these results as analyzed, but the Harris results do agree with observation of the these bread products. Although the statistical

Table 3 Mean measurements for standing height of five bread products (1)

	Height (cm)	Standard Error
Control "Rapid"	12.81a	0.62
15% Potato Flake	10.61a	0.62
29% Red Potato	11.61a	0.62
45% Idaho Potato	10.29a	0.62
100% Soviet Flour	13.00a	0.76

1. a Means in columns with unlike codes are different ($p < .05$).

analysis indicates the heights were not significantly different, observation of the breads indicated that a difference did exist. The 15% potato flake and 45% Idaho potato breads were consistently more compact when viewed next to the other bread products. Additional data, or measuring volume by displacement might allow the observed differences in standing height to be quantified.

4.02b Cell Size

The photocopies of the breads in Figures 2 through 6 record subjectively, by appearance, the cell size of the bread products. The bread cells appear darker in the photocopy and the quantity and size of the cells seems to increase from Figure 2 through Figure 6. Harris (1932) reported that the addition of potato to bread products increased gas production which may account for the more open cell structure in Figure 6 (45% Idaho potato). The photocopies of the 15% potato flake (Figure 2) and the 29% Red potato (Figure 5) do not appear to be effected by the addition of potato. According to cell size, based on the appearance, the breads were ranked in the following order, from smallest to largest cell size:

1. 15% Potato Flake and 100% Soviet flour, (Figures 2,3),
2. 100% Pillsbury flour (control) (Figure 4),
3. 29% Red Potato (Figure 5),
4. 45% Idaho Potato (Figure 6)

Figure 2 15% Potato Flake

Figure 3 100% Soviet Flour

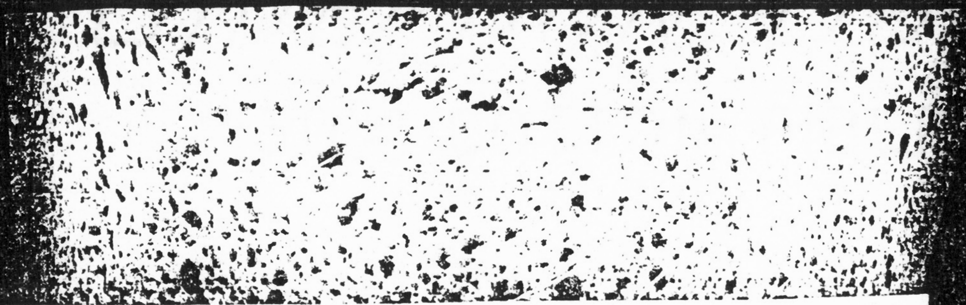


Figure 4 100% Pillsbury Flour (Control)

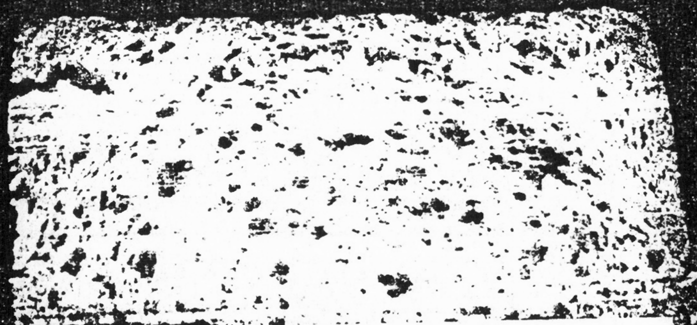


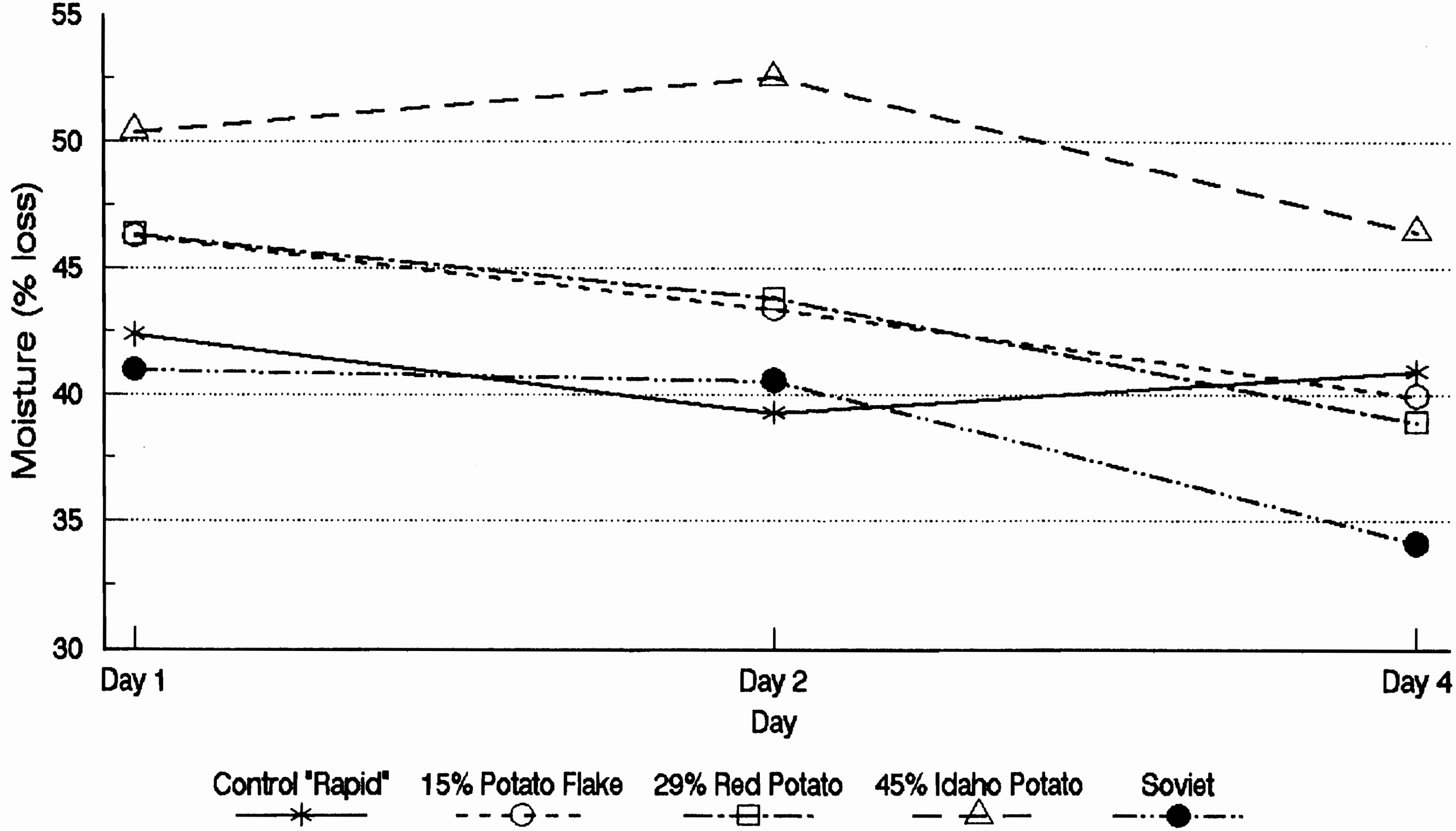
Figure 5 29% Red Potato

Figure 6 45% Idaho Potato

Generally, when the potato replacement exceeded 15%, the texture of the bread was open, with irregular and large cells formed by trapped leavening gases.

4.02c Moisture

The Brabender Moisture Tester (South Hackensack, New Jersey) was used to evaluate the moisture content of five bread products. The objective of this test was to measure the change of moisture content of the breads over four days. The mean moisture contents of the five breads measured over four days is shown in Figure 7. The lines representing the 45% Idaho potato, 15% potato flake, 29% red potato and 100% Soviet flour breads were parallel which indicated the percent moisture loss of the breads changed consistently over time. The percent moisture loss values decreased as the bread aged. Table 4 records the relationships among the breads on days 1, 2, and 4. On day 1 the control "rapid" and 100% Soviet flour breads were not significantly different in moisture percent loss (42.36% and 41.61%). These two breads had the lowest moisture percent loss of the five breads. The 15% potato flake and 29% Red potato breads were not significantly different from each other (46.28% and 46.34%) but both breads were significantly higher in moisture percent loss from the control "rapid" and 100% Soviet flour breads. The moisture percent loss was highest for the 45% Idaho potato bread (50.41%) and this bread was significantly different from all other breads. There was an approximate range of difference of 4% to 9%



1. Mean of 4 measurements, 2 replications.

Figure 7 Mean scores for percent moisture loss of five bread products measured over three days (1)

Table 4 Mean scores for percent moisture loss of five bread products on three days (1)

	Moisture Loss (%) Day 1	Moisture Loss (%) Day 2	Moisture Loss (%) Day 4
Control "Rapid"	42.36a	39.27a	40.91a
15% Potato Flake	46.28b	43.41b	39.96ab
29% Red Potato	46.34b	43.81b	37.90b
45% Idaho Potato	50.41c	52.55c	46.75c
100% Soviet Flour	41.61a	39.91a	34.13d

1. a,b Means in columns with unlike codes are different ($p < .05$)

between the breads that were grouped together (control "rapid" - 100% Soviet; 15% potato flake - 29% Red potato; and 45% Idaho potato).

The relationship among the breads remained constant on day 2, with a linear decrease in moisture percent loss for 15% potato flake, 29% Red potato, and the control "rapid" breads. The 100% Soviet flour bread decreased in moisture percent loss by less than 2%. The moisture percent loss for the 45% Idaho potato increased slightly, which could be the result of inadequate packaging or experimental error.

The mean scores for moisture percent loss remained constant on day 4, with a linear decrease indicated for 45% Idaho potato, 15% potato flake, 29% Red potato and 100% Soviet flour breads. The moisture loss stabilized after four days. The control "rapid" bread increased in moisture percent loss on day 4, which could be the result of inadequate packaging or experimental error.

The moisture percent loss for each of the breads (highest - lowest value) across the four days was: control "rapid" = 3.09%; 45% Idaho potato = 5.80%; 15% potato flake = 6.32%; 100% Soviet flour = 7.48%; 29% Red potato = 8.44%.

There was a significant difference among the breads in moisture percent loss. This difference in moisture could be accounted for by the high (77-95%) mean moisture content of potatoes, although the bread formulas were adjusted to compensate for the water content of the potatoes. The 45% Idaho potato bread had the highest moisture content and the second lowest total moisture percent loss over the four days (3.60%) The control "rapid" bread and the 100%

Soviet flour bread had the lowest moisture contents and the control "rapid" lost the least amount of moisture over the four days (3.09%). The 100% Soviet flour bread lost 7.48% moisture over the four days. The 29% Red potato bread lost the most moisture over the four days (8.44%). Although statistically significant differences exist among the moisture measurements of the breads, the practical significance of this difference might not be important. The loss of 3 to 8% moisture over four days, in breads that measured 41 to 50% moisture on the first day, might be difficult for consumers to detect.

4.02d Role of Bread In the Total Diet

Bread had an important role in the consumers' diets of the communities visited in the Soviet Far East. In Magadan, the largest city in this region, the manager of the local bakery stated that about 1 loaf of bread was baked per person per day, throughout the year (Magadan Bakery Manager, 1991). Bread was served as an accompaniment to meals that generally included another carbohydrate such as hot cereal, rice, or noodles.

My perception was that bread did not function as the primary protein source. Meat (beef, pork, chicken, fish) was a main ingredient in soup which was served as an entree or accompaniment in one or more meals a day. Full cream milk, sour cream, and curd products were abundant and consumed daily and would provide additional protein, as well as calcium and vitamins.

The substitution of potato products for wheat flour in bread would increase the percent protein (dry weight) when potato flakes, red potato, or Idaho potato replaced Soviet flour (Table 5). This difference was small and a statistical evaluation of a larger sample size may indicate no significant differences exist among the bread products.

4.02e Protein and Amino Acid Content of Breads

The mean percent protein content of three flours and five bread products was recorded in Table 5. As measured, the percent protein of the Gold Medal flour, purchased for use in baking breads in Juneau, Alaska, was 12.22%; the Pillsbury flour, purchased for breads baked in Virginia, was 12.44%; and the Soviet flour, purchased for breads baked in the Soviet Far East, was 11.29%. On a dry weight basis the protein content was 13.77%, 14.00%, and 12.64% respectively.

The protein content of the five breads was recorded in Table 5. The protein content (as measured) of the breads ranged from 6.82% to 7.18%. The protein content calculated on a dry weight basis, altered the relationship of protein contents among the breads. On a dry weight basis, the protein content of the 15% potato flake and 45% Idaho potato were slightly higher than the control "rapid" and 100% Soviet flour breads. As measured, the percent protein of the 15% potato flake and 45% Idaho potato breads was slightly lower than the control "rapid" and 100% Soviet flour breads.

Table 5 Mean percent protein content of three flours and five bread products (1)

	Protein (%) (as measured)	Protein (%) (dry weight)
FLOURS		
Gold Medal	12.22	13.77
Pillsbury	12.44	14.00
Soviet	11.29	12.64
BREADS		
Control "Rapid"	7.18	12.14
15% Potato Flake	7.16	12.61
29% Red Potato	6.82	11.97
45% Idaho Potato	6.69	13.33
100% Soviet Flour	7.14	11.62

1. Dry Weight = %Protein/[100 - %Moisture]/100

The amino acid analysis of the bread products is recorded in Table 6. The glutamic acid content of the five breads ranged from 4.154g/100g to 4.681g/100g and was the most abundant amino acid measured. The proline content of the breads ranged from 1.293g/100g to 1.452g/100g and was second to glutamic acid in abundance. Methionine was not present in the samples measured. Low levels of lysine were recorded. Cysteine was not present in the 100% wheat flour breads (Soviet flour and Pillsbury flour) and the 15% potato flake bread but small amounts were measured in the breads made from fresh potatoes (29% Boiled-mashed [Red potato], 45% Boiled-mashed [Idaho potato]). Except for small variations the amino acid contents of the five breads were similar.

The protein and amino acid contents of the flours and of the breads were similar. These measurements were consistent with data on protein content of wheat flours and breads noted in Zapsalis and Beck (1986) and Smith (1968). The gliadin and glutenin components of gluten are particularly high in glutamine and proline. Glutamine, converted to glutamic acid during the analysis process, was the most abundant amino acid present. Proline was the second most abundant. These measurements should be highest in the 100% Soviet flour and the Pillsbury flour breads where the protein content of the flour was not diluted by potato. Potato does not contain the gliadin and glutenin components of gluten and should have smaller amounts of glutamine and proline, but this relationship was not reflected in the amino acid measurements.

Table 6 Amino acid analysis of two flours and three potato bread products (1)

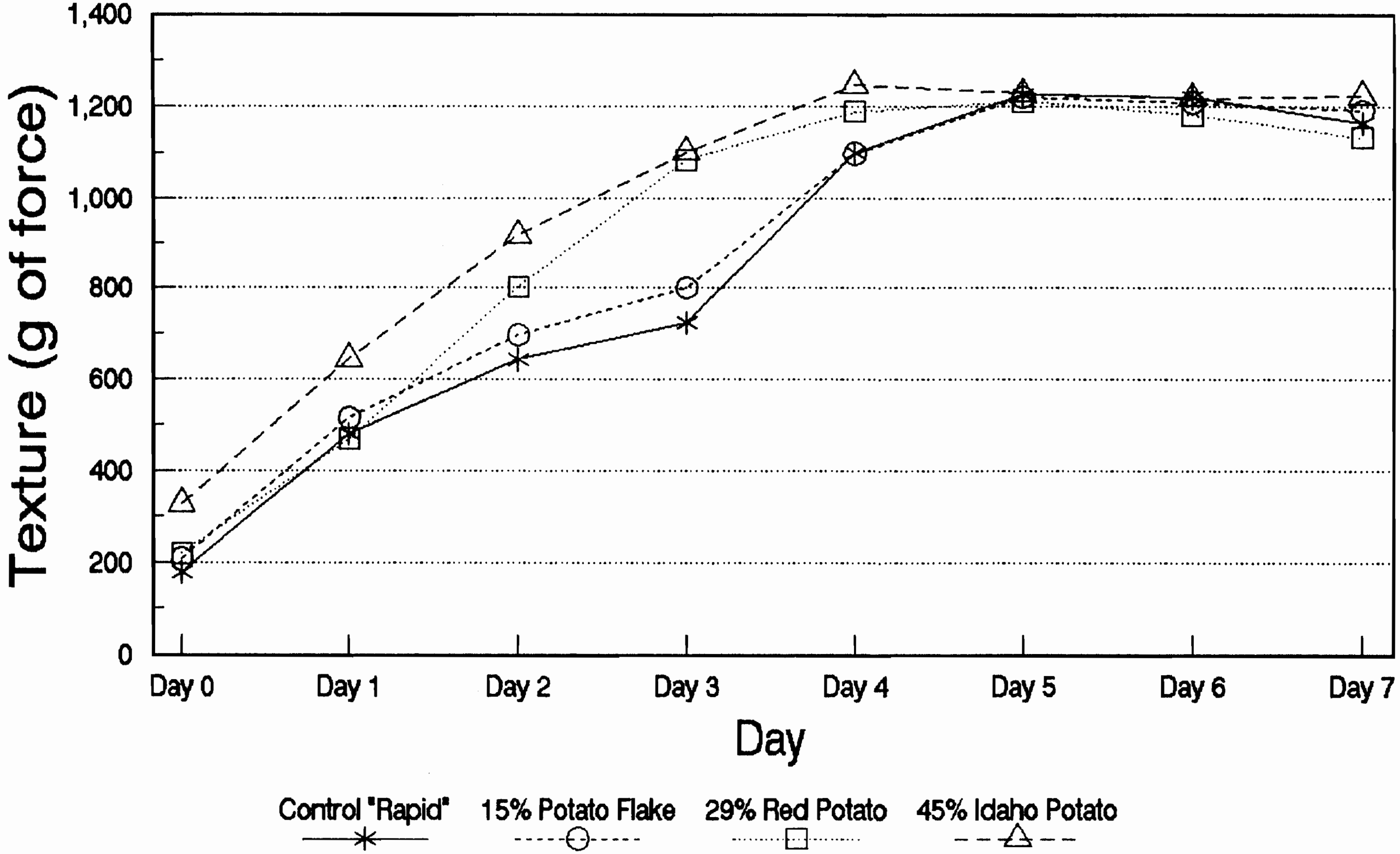
	Soviet Flour (g/100g)	Pillsbury Flour (g/100g)	45% Idaho Potato (g/100g)	29% Red Potato (g/100g)	15% Potato Flake (g/100g)
Aspartic Acid	0.857	0.875	1.053	0.934	1.061
Glutamic Acid	4.586	4.681	4.380	4.154	4.585
Serine	0.617	0.475	0.581	0.498	0.489
Glycine	0.319	0.355	0.364	0.358	0.358
Histidine	0.246	0.278	0.258	0.239	0.262
Arginine	0.901	0.929	0.937	0.879	0.741
Threonine	0.276	0.321	0.333	0.298	0.310
Alanine	0.310	0.330	0.335	0.339	0.339
Proline	1.293	1.436	1.394	1.293	1.452
Tyrosine	0.407	0.476	0.452	0.402	0.504
Valine	0.382	0.446	0.408	0.423	0.456
Methionine	0.000	0.000	0.000	0.000	0.000
Cysteine	0.000	0.000	0.251	0.222	0.000
Isoleucine	0.587	0.668	0.642	0.382	0.621
Leucine	0.640	0.728	0.661	0.571	0.712
Phenylalanine	0.431	0.502	0.447	0.381	0.493
Lysine	0.268	0.323	0.304	0.249	0.259
AA Total	12.121	12.823	12.549	11.621	12.644
Crude Protein	7.145	7.185	6.670	6.923	7.114

1. 2 controls; 3 experimental breads.

4.02f Analysis of Freshness

The results of an analysis of freshness texture evaluation of four bread products during seven days are recorded in Figure 8. A logarithmic relationship was shown between the texture (grams[g] of force) measurement over the seven days. The texture measurement for the 45% Idaho potato was higher than the other three breads from day 0 to day 5 which means that the grams of force required to compress the 45% Idaho potato bread exceeded the force required for the 29% Red potato, 15% potato flake, and control "rapid" breads. The texture measures for the 29% Red potato, 15% potato flake, and control "rapid" breads were similar for days 0 and 1. The 15% potato flake and control "rapid" bread texture measurements remained similar throughout the seven day cycle. After day 1, the 29% Red potato breads grams of force measurements increased at an accelerated rate, and by day 3 had reached the 45% Idaho potato level. At day 4 the 45% Idaho potato and 29% Red potato had reached maximum texture measurements and plateaued from day 4 to day 7. At day 5, the 15% potato flake and control "rapid" breads reached the plateau level of the 45% Idaho potato and 29% Red potato breads and the four breads maintained similar texture measurements until day 7.

The analysis of freshness data recorded in Figure 8 shows rapid increases in the texture measurements (grams of force) of the breads between days 1 and 4. The 45% Idaho potato bread had the highest texture measurements from the day of baking through day 4. This bread was also highest in moisture content.



1. Each point represents a mean of 12 measurements.

Figure 8 Mean measurements for analysis of freshness of four bread products evaluated over eight days (1)

According to Jain and Sherman (1974) an increase in the moisture content of breads through the addition of potato, increases the bread's softness. The control "rapid" bread with no potato added measured lowest in this analysis of freshness.

The staling curve when compared to the analysis of freshness curve had a similar rapid rise in measurements from day 1 to day 4 for all breads. The order of the breads on the curve is reversed, the 45% Idaho potato bread had the highest grams of force measure and the lowest area/mg measure for staling. The grams of force required to deform the product to a specified depth does not relate to the amount of energy required to break the hydrogen bonds in differential scanning calorimetry (staling).

4.02g Staling as Measured by Differential Scanning Calorimetry

The mean measurements (area/milligram) of staling for five breads, as measured by differential scanning calorimetry, are recorded in Table 7. Differential scanning calorimetry measured the heat required to break the hydrogen bonds formed during staling in the bread samples, this measurement is recorded as an exothermic curve. The area under the curve increased over the staling period (Russell, 1983). The area under the curve was calculated and divided by the sample weight in milligrams (area/milligram). The logarithmic curves that represent the mean measurements (area/milligram) for the five breads are shown in Figure 9. The most rapid staling for the five breads occurred between days 1 and 4, with staling continuing at a decreased rate through day

Table 7 Mean measurements (area/mg) of staling by differential scanning calorimetry for five bread products on each of six days

	Day 1	Day 2	Day 4	Day 7	Day 10	Day 14
Control "Rapid"	10.06	18.07	22.83	23.27	25.35	27.82
15% Potato Flake	6.62	10.64	14.57	17.57	21.90	26.02
29% Red Potato	8.75	12.89	15.25	22.74	23.57	27.90
45% Idaho Potato	5.16	9.12	12.97	16.23	21.31	25.44
100% Soviet Flour	8.96	13.25	21.61	24.17	27.22	28.45

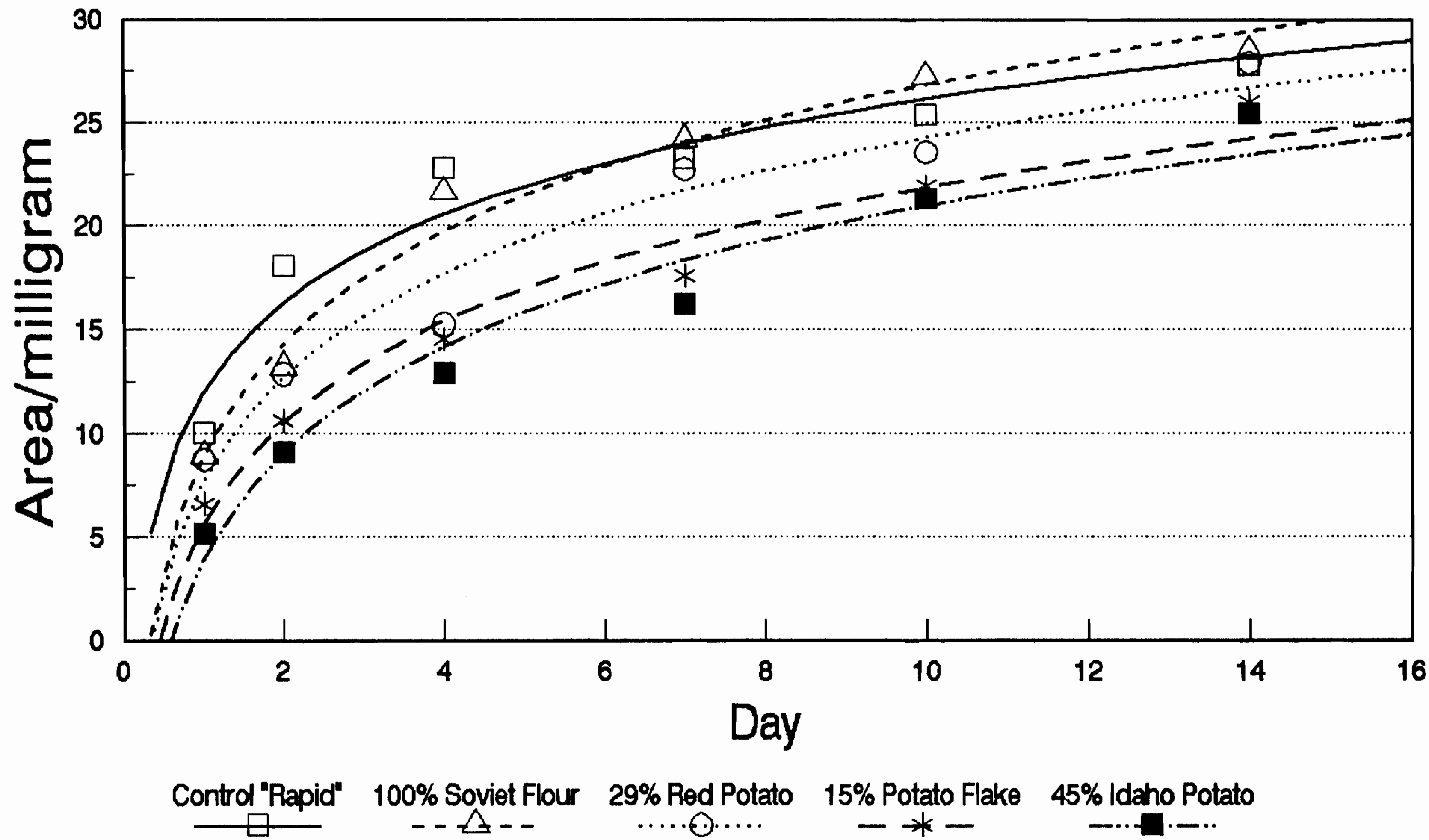


Figure 9 Plot of mean measurements (area/milligram) of staling by differential scanning calorimetry for five breads over fourteen days

14. These results are consistent with research by Czuchajowska and Pomeranz (1989) in their evaluation of staling, moisture content, and water activity of breads during storage.

On day 1 (24 hours after baking) the table and figure indicate the staling measurement of the control "rapid" bread was the highest (10.06 area/mg). The 100% Soviet flour and the 29% Red potato breads had similar measurements of 8.96 and 8.75 area/mg, respectively. The 15% potato flake and 45% Idaho potato breads had the lowest staling measurements (6.62 and 5.16 area/mg) for day 1. The relative position and rate of increase of the bread staling measurements in Figure 9 remain constant except for the 100% Soviet flour bread. The rate of staling for this bread was higher than the other four breads and approached the measurements of the control "rapid" bread by day 4. The 29% Red potato bread maintained a staling curve midway between the 100% wheat flour breads and the 15% potato flake and 45% Idaho potato breads.

Table 8 records the mean measurements (area/mg) of staling for the five breads over the fourteen days. The control "rapid" and 100% Soviet flour breads had the highest staling measurements (area/mg) and were not significantly different from each other in the total amount of staling that occurred during the fourteen days. The 15% potato flake and 45% Idaho potato breads were not significantly different from each other during that same time period but both breads had significantly lower staling measurements than the control "rapid" and

Table 8 Mean measurements (area/mg) of staling by differential scanning calorimetry for five bread products over fourteen days (1)

	DSC (area/mg)	Standard Error
Control "Rapid"	21.24b	0.51
15% Potato Flake	16.22a	0.51
29% Red Potato	18.52c	0.51
45% Idaho Potato	15.04a	0.51
100% Soviet Flour	20.61b	0.51

1. a,b,c Means in columns with unlike codes are different ($p < .05$)

100% Soviet flour breads. The 29% Red potato bread was significantly different from the other four breads.

If replacement levels with potato products were the only factor responsible for the staling measurements, the 29% Red potato and 15% potato flake curves should have been reversed. The higher potato content of the 29% Red potato bread would have resulted in a lower staling curve. Recent research by Czuchajowska and Pomeranz (1989) and Hoseney (1991) provide new information on staling as a function of the retrogradation of amylopectin crystallites, that may explain these results. Red potatoes are described as waxy and waxy starches have a higher proportion of amylopectin than the mealy starches. Idaho potatoes are described as mealy and are used to make potato flakes. The higher level of waxy starch, or amylopectin, in the 29% Red potato bread may explain why this bread stales more rapidly than the 15% potato flake bread.

The staling measurements are consistent with research by Harris (1932), Jain and Sherman (1974), and Knorr (1977) that documented reduction in staling rates for breads containing cooked potato, potato flakes, and potato protein using methods other than differential scanning calorimetry.

4.03 Sensory Evaluation of Bread Products

The objectives of the sensory evaluation of the bread products was to define the characteristics of the breads with Quantitative Descriptive Analysis (QDA) and to determine the acceptability of the breads in central location acceptance tests carried out in four locations. In this manner the differences among breads were identified and quantified and the acceptance was measured by degree of liking.

4.03a Quantitative Descriptive Analysis (QDA)

The mean scores of the ten characteristics judged by an eleven member trained panel are recorded in Tables 9, 10, and 11. To facilitate discussion of the results refer to the list of bread characteristics and references in Appendix (3.05b[i]). The characteristics for each bread sample were scored on a 15 cm line, with anchor words to the left describing the lower levels of a characteristic and anchor words to the right describing higher levels of the characteristic (Appendix, 3.05b[ii]). Anchor words are included in the footnotes of each table.

4.03a(i) Crust Color

The control "rapid" bread was scored as significantly lighter in crust color than the other four breads. The control "commercial", 15% potato flake, 29% Red potato, and 45% Idaho potato bread were not significantly different in crust color.

Table 9 Mean scores for sensory characteristics of five bread products as scored by eleven panelists (1,2)

	Crust Color	Cell Size	Cell Uniformity	Crumbly
Control "Rapid"	4.15a	5.72a	7.43ab	5.96a
Control "Commercial"	6.78b	8.01b	6.12b	6.41a
15% Potato Flake	6.29b	5.04a	8.41a	3.39b
29% Red Potato	5.86b	6.64ab	6.67ab	4.27ab
45% Idaho Potato	5.29b	7.68b	6.01b	3.39b

1. Crust Color:0=light,15=dark; Cell Size:0=small,15=large;
Cell Uniformity:0=less,15=more; Crumbly:0=less,15=more.
2. a,b Means in columns with unlike codes are different ($p < .10$)

Table 10 Mean scores for sensory characteristics of five bread products as scored by eleven panelists (1,2)

	Moisture	Potato Flavor	Aftertaste
Control "Rapid"	7.13a	2.16a	2.77a
Control "Commercial"	8.02ac	2.67ab	3.14a
15% Potato Flake	10.71b	4.55b	3.45a
29% Red Potato	10.14bd	3.62ab	2.59a
45% Idaho Potato	10.74b	4.40ab	2.95a

1. Moisture:0=less,15=more;Potato Flavor:0=mild,15=strong;
Aftertaste:0=mild,15=strong.
2. a,b Means in columns with unlike codes are different ($p < .10$)

Table 11 Mean scores for sensory characteristics of five bread products as scored by eleven panelists (1,2)

	Chewiness	Adhesiveness	Crust Hardness
Control "Rapid"	7.23a	2.18a	5.13a
Control "Commercial"	7.19a	2.36ab	7.90b
15% Potato Flake	7.33a	3.54ab	4.61a
29% Red Potato	7.40a	3.00ab	5.36ab
45% Idaho Potato	7.31a	3.91b	4.62a

1. Chewiness:0=less,15=more; Adhesiveness:0=less,15=more;
Crust Hardness:0=soft,15=hard.
2. a,b Means in columns with unlike codes are different ($p < .10$)

These breads were judged to have a medium crust color which would be similar to the molasses whole wheat bread used as a reference in training.

4.03a(ii) Cell Size

The cell size of the control "rapid", 15% potato flake, and 29% Red potato were judged to be similar with scores of 5.72, 5.04, and 6.64 respectively. The cell size of the 29% Red potato, 45% Idaho potato, and control "commercial" breads were judged to be similar with scores of 6.64, 7.68, and 8.01 respectively. The control "rapid" and 15% potato flake breads had significantly smaller cell sizes than the control "commercial" and 45% Idaho potato breads. The 29% Red potato bread was not significantly different from the other four breads. The control "commercial" bread was judged to have the largest cell size and the 15% potato flake the smallest cell size. According to cell size, based on the mean scores for the samples, the breads were ranked in the following order, from smallest to largest cell size:

1. 15% potato flake,
2. Control "rapid" (100% Pillsbury flour),
3. 29% Red potato,
4. 45% Idaho potato,
5. Control "commercial."

The cell size of the breads was ranked in the same order from the photocopies (Figures 2-6).

4.03a(iii) Cell Uniformity

The control "rapid" and the 29% Red potato breads were not significantly different from the other breads and had scores of medium cell uniformity. Generally the cell size was 1-2 mm in diameter, with cells of 2-5 mm in diameter occurring more frequently in less uniform breads. The 15% potato flake bread was similar to the control "rapid" and 29% Red potato breads. The 15% potato flake bread was judged significantly more uniform than the control "commercial" and the 45% Idaho potato breads. Cell uniformity scores for all five breads were clustered in the middle of the 15 cm line scale.

4.03a(iv) Crumbly

The control "rapid" and control "commercial" breads were judged as similar in the crumbly characteristic. The scores were in the mid-range between soft white bread products (less crumbly) and a multi-grain bread (more crumbly). The 15% potato flake, 29% Red potato, and 45% Idaho potato breads were not significantly different. The 15% potato flake and 45% Idaho potato breads, with scores of 3.39 were judged as the least crumbly breads.

4.03a(v) Moisture

The moisture content of the control "rapid" and control "commercial" breads were judged not significantly different. The moisture content of the three potato breads (15% potato flake, 29% Red potato, 45% Idaho potato) were also not significantly different. The panelists found the moisture content of all potato breads significantly higher than the two controls. The 15% potato flake and 45% Idaho potato breads were the most similar in scores for the moisture characteristic. In order of perceived moisture, the panelists judged the two controls to be least moist, the 29% Red potato bread in the middle, and the 15% potato flake and 45% Idaho potato as the most moist. The order judged by the panelists when compared to the measurements of percent moisture loss varied only in the location of the 15% potato flake bread. In the moisture loss study the 15% potato flake and 29% Red potato were not significantly different.

When panelists judged the moisture of the bread products the scores indicated they could perceive the moist mouthfeel of the potato breads. A moist mouthfeel makes a bread seem less stale and extends the shelf-life of the product. Staling and moisture contents of breads are not objectively related in the bread system but they are related in the quality of the product as perceived by consumers.

4.03a(vi) Potato Flavor

The 15% potato flake bread, when compared with the control "rapid" bread was judged to have a significantly stronger potato flavor. The potato flake product's score indicated a mild to medium potato flavor. The 45% Idaho potato bread was the most similar to the 15% potato flake in flavor but not statistically different from the other breads in potato flavor. In general the panelists judged the breads as mild in potato flavor and could not distinguish between breads with and without potato products.

4.03a(vii) Aftertaste

The scores for aftertaste for the five breads were not significantly different. The scores indicated the panelists found the breads had mild aftertastes.

4.03a(viii) Chewiness

The chewiness characteristic for the five breads was not significantly different. The scores were centralized between the less chewiness anchor which was described as "like a biscuit", and the more chewiness anchor which was described as "like French bread or bagels."

4.03a(ix) Adhesiveness

The control "rapid" bread was scored as significantly less adhesive than the 45% Idaho potato bread. The control "rapid", control "commercial", 15% potato flake, and 29% Red potato were judged to be similar. The control "commercial", 15% potato flake, 29% Red potato, and 45% Idaho potato breads were also judged as similar. The scores ranged from 2.18 to 3.91 which indicated less adhesive bread products.

4.03a(x) Crust Hardness

The control "rapid", 15% potato flake, 29% Red potato, and 45% Idaho potato breads were judged to be similar in crust hardness. The crust of the control "commercial" bread was judged to be significantly harder than the control "rapid", 15% potato flake, and 45% Idaho potato breads. All the bread crusts could be described as soft to medium in hardness.

4.03a(xi) Summary of QDA Results

The statistical analysis of the sensory characteristics of the bread products indicated some significant differences existed. The statistical method used was powerful and detected relatively small differences in scores. With the exception of moisture, the characteristic scores for the five bread products had a spread of 1 to 3 points on a 15 point scale. In a practical sense the ability of panelists to detect differences in that range would be questionable.

In general, the 100% wheat flour and potato bread products evaluated by the QDA panelists would be characterized as similar in sensory qualities. The addition of potato products to bread as a means of extending the supply of flour would yield a bread product similar in sensory characteristics to 100% wheat flour bread. If consumers are able to detect the higher moisture content of potato breads without characterizing the bread as "different" in other characteristics from non-potato bread, the consumer would benefit from the perception, as well as the actuality, of longer shelf-life.

4.03b Central Location Acceptance Tests

The results from the central location acceptance tests were evaluated for the five breads: control "rapid", control "commercial", 15% potato flake, 29% Red potato, and 45% Idaho potato at each location: Juneau, Alaska; Anadyr, Magadan, and Ola, USSR (Table 12, columns). The results were also evaluated across locations for each bread (Table 12, rows). The 45% Idaho potato recipe was baked only in Juneau, Alaska. The recipe was altered to 29% Red potato for use in the USSR locations. The control "commercial" was purchased at each location and represented the customary bread consumed at the location. It should be noted that only one kind of bread was available in the USSR locations visited and age of the bread was not known. Acceptance was measured by degree of liking on a hedonic scale. A score of 1 corresponds to the descriptor "dislike", and a score of 7 corresponds to the descriptor "like" (Appendix, 3.03b[iii]).

4.03b(i) Juneau, Alaska, USA

In Juneau, Alaska the control "rapid", 15% potato flake, and 45% Idaho potato breads were liked significantly more than the control "commercial" bread. The control "rapid", 15% potato flake, and 45% Idaho potato breads were scored as similar in degree of liking (5.00, 4.60, 4.85 respectively). These scores, on a 7 point scale, indicate the consumers felt neutral about the breads.

Table 12 Central location mean acceptance scores of five bread products in four locations (1,2,3)

	Juneau Alaska, USA	Anadyr USSR	Magadan USSR	Ola USSR
Control "Rapid"	5.00aB	6.29bB	6.10bB	5.90bB
Control "Commercial"	3.37aA	3.47aA	3.33aA	4.05aA
15% Potato Flake	4.60aB	5.59abB	5.89bB	5.81bB
29% Red Potato	----	6.35bB	5.97bB	6.38bB
45% Idaho Potato	4.85aB	----	----	----

1. Scores: 1=dislike; 7=like.
2. A,B Means in columns with unlike codes are different ($p < .05$).
3. a,b Means in rows with unlike codes are different ($p < .05$).

4.03b(ii) Anadyr, USSR

In Anadyr, USSR the control "rapid", 15% potato flake, and 45% Idaho potato breads were liked significantly more than the control "commercial" bread. The three experimental breads of control "rapid", 15% potato flake, and 29% Red potato were scored as similar in degree of liking (6.29, 5.59, 6.35 respectively). The level of these scores indicated the consumers liked the breads.

4.03b(iii) Magadan, USSR

In Magadan, USSR the control "rapid", 15% potato flake, and 45% Idaho potato breads were liked significantly more than the control "commercial" bread. The three experimental breads were scored as similar in degree of liking (6.10, 5.89, 5.97 respectively). The level of these scores indicated the consumers liked the breads.

4.03b(iv) Ola, USSR

In Ola, USSR the control "rapid", 15% potato flake, and 45% Idaho potato breads were liked significantly more than the control "commercial" bread. The control "rapid", 15% potato flake, and 45% Idaho potato breads were scored as similar in degree of liking (5.90, 5.81, 6.38 respectively). The level of these scores indicated the consumers liked the breads.

4.03b(v) Results by Bread Across Locations

The control "rapid" bread was liked significantly less in Juneau (5.00) than in Anadyr (6.29), Magadan (6.10), or Ola (5.90). Scores in the 5 to 6 range indicated that consumers moderately liked the bread. The consumers judged the control "commercial" breads as similar in all locations. The scores for this bread across locations ranged from 3.33 to 4.05, which indicated consumers moderately disliked the bread. The 15% potato flake bread was liked significantly more by consumers in Magadan and Ola than by those consumers testing the bread in Juneau. The consumers testing the bread in Anadyr scored the bread as not significantly different from Juneau, Magadan, or Ola. The scores indicated a low to moderate degree of liking of the breads. The 29% Red potato bread tested by consumers in Anadyr, Magadan, and Ola was liked significantly more than the 45% Idaho potato bread tested in Juneau. The scores for the 29% Red potato bread in the three USSR communities indicated that the consumers had a moderate to strong degree of liking for this bread. Across the three locations in the USSR there were no significant differences in the consumers' scoring of each bread product.

4.03c Central Location Acceptance Test Survey

Every third acceptance scoresheet was marked to indicate that the consumer was requested to participate in answering seven additional questions about the bread products tested. The answers were compiled for all locations

(Appendix 4.03c). The frequency of answers for three questions was determined and the information recorded in Figures 10, 11, and 12. The control "commercial" breads were purchased locally for each acceptance test. In Juneau, the Idaho potato bread replacement level was 45% and in the USSR communities the replacement level was 29% with red potato.

In Figure 10, the frequency of answers to the question, "which bread did you like the most?" is shown. In Juneau and Anadyr approximately 50% of the respondents indicated the potato bread products, 15% potato flake and 45% Idaho potato or 29% Red potato, were liked the most. In Magadan and Ola over 50% of the respondents indicated the potato bread products were liked the most. The control "rapid" bread was chosen more frequently than the control "commercial" in answer to this question. The control "rapid" bread was chosen as the bread liked most by the most consumers in Juneau and Anadyr, it was chosen less frequently in Magadan and Ola.

The next survey question asked the consumer to "describe what you liked about this bread sample." In Juneau, Anadyr, Magadan, and Ola the following descriptive words were documented. The texture of the control "rapid" bread was described by Juneau consumers as chewy, and heavier; the taste was described with the words sweeter, not salty, and more flavor. In the three communities of the Soviet Far East the control "rapid" bread's texture was described as airy, tender, porous, and soft; the taste was described with the words sweet, tasty, like a bun, and like homemade. In Juneau, the 15% potato flake bread's texture was

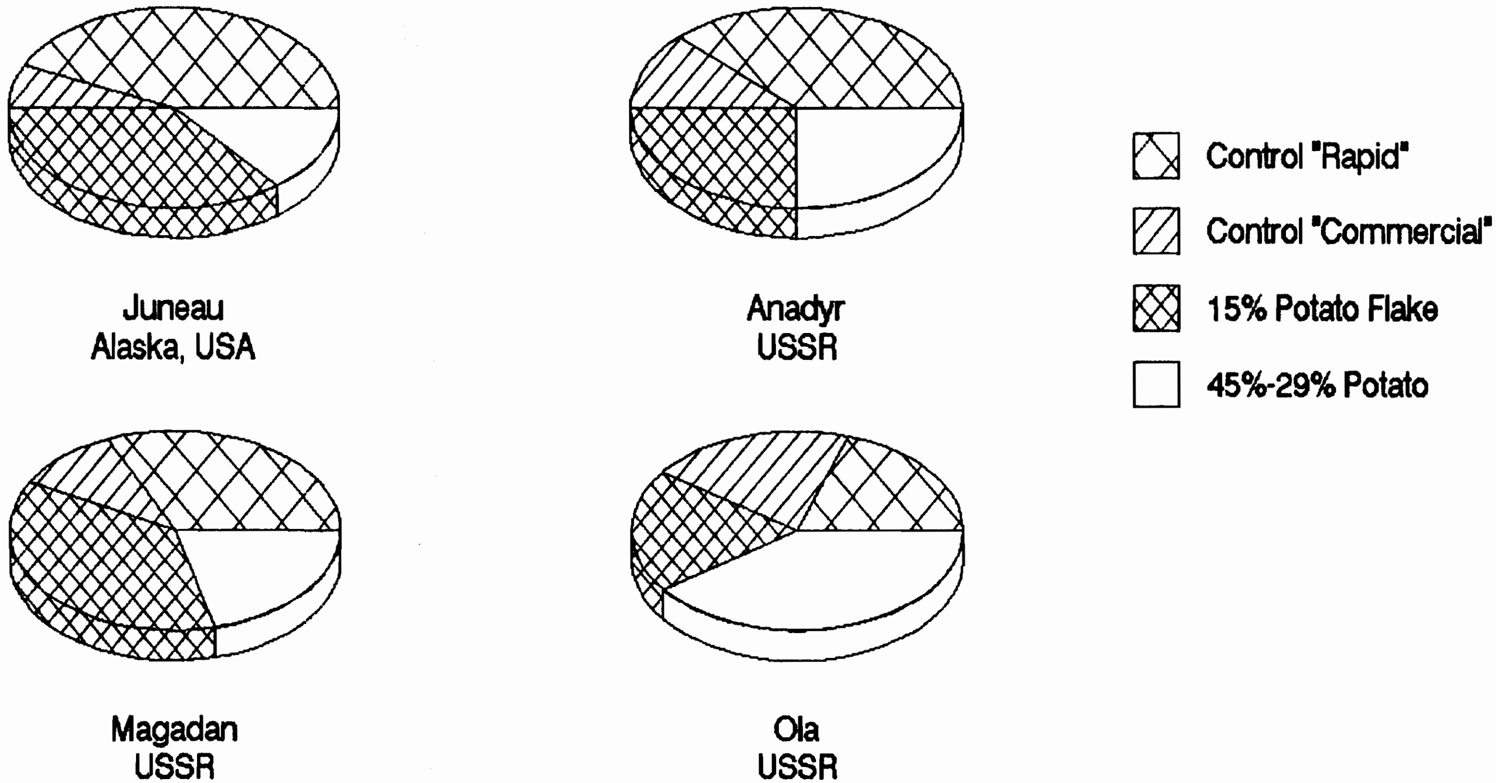


Figure 10 Frequency of responses to acceptance test survey question, "which bread did you like the most?" in four locations

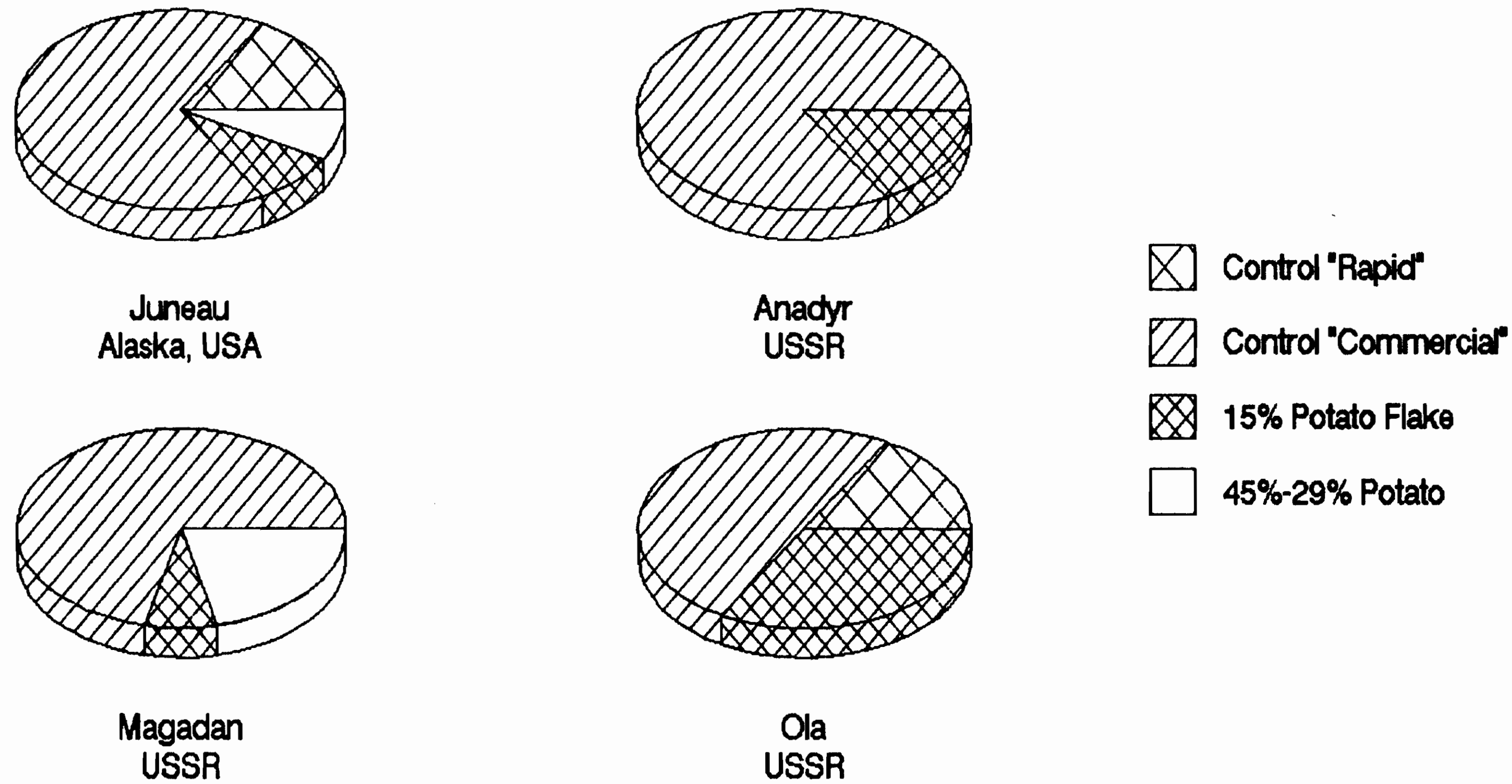


Figure 11 Frequency of responses to acceptance test survey question, "which bread did you like the least?" in four locations

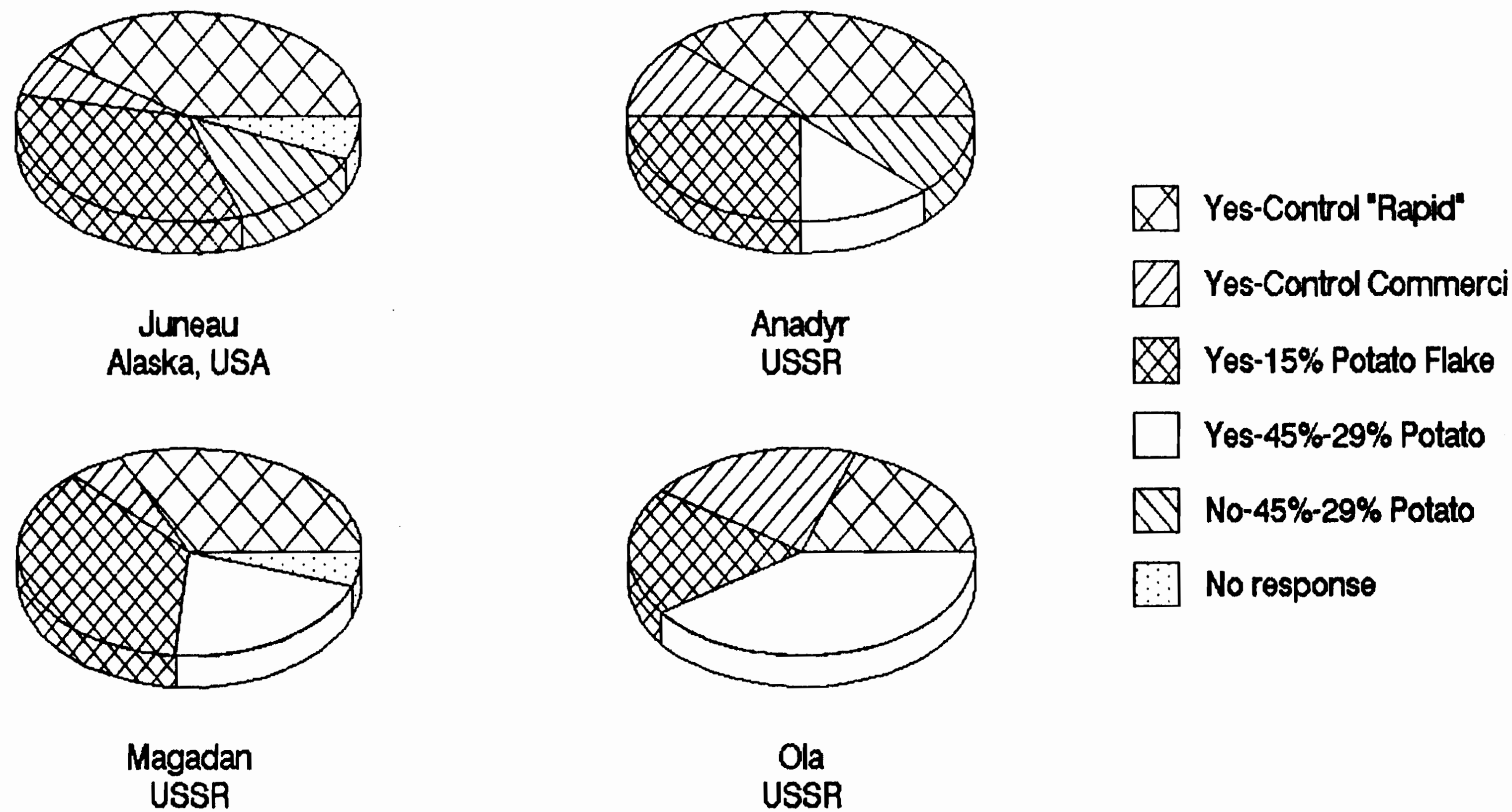


Figure 12 Frequency of responses to acceptance test survey question, "if the bread you like the most was available in a store would you buy it?" in four locations

considered more chewy, moist, and heavier; the taste was considered too sweet, and like homemade. In Anadyr, Magadan, and Ola the texture of the 15% potato flake bread was described with the words porous, tender, soft, and airy. One consumer commented that the bread had a pleasant color and another said, "It's good, that's all." The 45% Idaho potato bread was described by Juneau consumers as not as heavy, lighter with a taste like sourdough. The 29% Red potato bread in the Soviet Far East communities was described by the words porous, airy, aromatic and like good homemade bread. Consumers in the Soviet Far East who chose the control "commercial" bread as the one liked most, described it as coarse, tasty, soft, porous and indicated they liked the bread because that's what was customary.

Consumers in Juneau described the potato breads as heavier and the consumers in Anadyr, Magadan, and Ola described the same breads as airy and porous. The difference was probably relative to each location's "customary" bread.

In Figure 11 the frequency of responses to the question, "which bread did you like the least?" are shown. The control "commercial" bread was consistently chosen as the bread liked the least in all locations. The responses in Juneau indicated that the control "rapid", 15% potato flake, and 45% Idaho potato breads were disliked by some consumers. In Anadyr, the 15% potato flake bread was disliked by some consumers. In Magadan, the 15% potato flake and 29% Red potato breads were disliked by some consumers. In Ola, 50% of the responses indicated that consumers disliked the control "rapid" and 15% potato flake breads.

The fourth survey question asked the consumer to "describe what you disliked about this bread sample." In Juneau, Anadyr, Magadan, and Ola the following descriptive words were documented in response to question 4. In Juneau the texture of the control "commercial" bread was described as too light, doughy, and not like whole grain. The taste of this bread sample was described as yeasty, salty, or too little taste. In Anadyr, Magadan, and Ola the control "commercial" bread texture was described as coarse, unleavened, not porous, and stale. The taste was described with the words sour and tasteless. Other comments by consumers in the USSR indicated they liked their "Soviet" bread with soup and they liked this sample because "it is customary." The 15% potato flake and 29% Red potato breads were also liked least by some consumers. Characteristics described by the consumers were sourness of taste, unleavened texture, and in general "not so delicious".

In Figure 12, the frequency of responses to the question, "if the bread you like most was available in a store would you buy it?" are shown. If the breads liked most by consumers were available in the store, consumers indicated they would buy the bread. The only bread consumers in Juneau and Anadyr indicated they would not buy was the 45% Idaho potato bread. All consumers who liked the 15% potato flake or control "rapid" bread most would buy it.

4.03d Discussion of QDA and Central Location Tests

The results from the QDA evaluation of the breads indicated that panelists judged the potato breads and control bread to be similar in all sensory characteristics except moisture. The central location acceptance tests indicated that consumers in one USA location and in three USSR locations liked the potato breads and the 100% wheat flour bread baked in the home bakery appliance (control "rapid") more than the locally purchased, commercially baked bread. The control "rapid" bread was as acceptable to consumers as the potato breads.

These results documented that in Alaska and the USSR, replacement of bread flour with potato products yields breads that are acceptable to consumers. The potato breads are judged as similar to the 100% wheat flour bread (control "rapid"). The potato breads were perceived to have higher moisture contents, and staling measurements verified previous research that recorded increased shelf-life with the addition of potato products. In the Soviet Far East, extending both the supply of flour and the shelf life of bread would be beneficial. Flour must be imported from other Soviet regions which increases the subsidized cost of the bread. Replacing portions of flour with locally available potatoes would allow efficient utilization of both the flour and the potatoes.

In acceptance tests, the potato breads were judged to be similar in degree of liking. Since potato flakes were not readily available in the Soviet Far East, it is important to note that consumers would find the 29% Red potato bread made from boiled-mashed potato equally acceptable. Although preparing the potatoes would require extra equipment and space, the process would be technically feasible, even in small community bakeries.

Breads baked in local Soviet bakeries were not packaged after baking. The loaves were cooled in wooden boxes that were moved to a loading area for distribution by truck to local shops. The loaves seemed to stale quickly under these conditions. Addition of potato to the breads would decrease the rate of staling and provide consumers with a bread that is perceived as more moist.

4.04 Collaborative Development Process

The Collaborative Development Process model (Figure 1) is an expanded and adapted version of the implicit model that was used to organize the potato bread research in the Soviet Far East. The Collaborative Development Process was designed for two purposes; first as a tool for reviewing the implicit research approach, and second, as a planning tool for designing future food product research in international settings.

The three components of the collaborative development process are: 1) the people involved, 2) the problem defined, and 3) the solution process (Figure 1). The design of the potato bread research in the Soviet Far East will be reviewed in terms of the expanded Collaborative Development Process model that was adapted from the writings of Lofquist (1983, 1989), Rogers and Shoemaker (1971), and IPC (1982, 1983, 1985a, 1985b).

4.04a The People Involved

The specialists, users, and policy makers are three groups of people commonly involved in the development process. An effective development process is designed as a collaborative effort of individuals from these groups. This process also promotes the view that the user is a resource and facilitates participation of users within each component of the process framework.

Specialists from three universities: 1) Virginia Tech in Blacksburg, Virginia, 2) University of Alaska in Anchorage, Alaska, and 3) the Institute for Biological Problems of the North in Magadan (USSR), were involved in the development process that resulted in the potato bread research. Specialists from Virginia Tech included faculty from the Department of Human Nutrition and Foods and the Cooperative Extension Service. Individuals from this institution provided knowledge and expertise in the areas of food product development, international development, and evaluation. Specialists from the University of Alaska included a horticulture agent and an agriculture agent who shared information about northern potato varieties in Alaska and the Soviet Far East. Specialists from the Magadan Institute for Biological Problems of the North included geneticists, who assisted in designing the information gathering and testing stages of this research. The translator for the research was a member of this genetics lab.

A second group of collaborators are the users. Consumers acted as resources in the testing and adaptation of bread products by sensory evaluation.

Policy makers are the third group of collaborators. In this research the Coordinator of the Office for Soviet Relations, University of Alaska-Anchorage would be designated a policy maker. He formed the link between Virginia Tech and the Magadan Institute for Biological Problems of the North and determined if and how the research would proceed. Other policy makers would include the director of the Magadan Institute for Biological Problems of the North and the Deputy Minister of Agriculture in Magadan.

In future research the core of people involved would need to be expanded to include bakers in the user group, and those policy makers who have the power to determine the amount and kind of bread baked. Another limitation recognized during the planning phase, and later while working in the Soviet Far East, was the lack of Soviet specialists in food technology. Consumer foods research frequently occurs outside a laboratory and utilizes methodologies that focus on determining what choices consumers make in the market place and why they make those choices. The genetics lab at the Magadan Institute employs laboratory scientists who found the concept and methodology involved with food research difficult to understand from an occupational and cultural perspective.

The people involved in this research acted primarily as resources on an individual basis, not as a collaborative unit. At the Institute for Biological Problems of the North communication channels were linear. The research needs and requests were explained to the translator and she passed the requests on to her supervisor. In turn, the supervisor delegated the requests to other people who responded to the researcher. Future food product research would benefit from the formation of a collaborative group in the planning stages of the research, if possible within the culture. Although distances make face-to-face meetings difficult or impossible; audio-conferences, facsimile messages, telephone conversations, and correspondence may help to build a collaborative relationship among the people involved. A collaborative unit would act as a resource at the problem definition and solution process stages.

4.04b The Problem Defined

Recognition that a problem exists is the first step in a collaborative development process. Defining the problem involves identification of the problem, the indicators, and the goal by the specialists, policy makers and users.

The problem or need is the current reality. The problems for this research were identified during a research exchange to the Soviet Far East in July, 1989. The problems identified were:

1. Consumers needed more bread,

2. Potatoes were an abundant crop with high storage losses and one primary use.

The goal represents how the future is visualized when the problem is solved. The goals for this process model were to provide a future where:

1. Bread is available and accessible when consumers need or want to buy it.

2. Potatoes are an abundant crop with minimum storage losses and multiple uses.

Indicators are pieces of evidence that assist in defining the problem, developing a strategy for solving the problems, and marking progress toward the goal. Indicators that assisted in identifying that consumers needed more bread were:

1. The rationing of bread.

2. The low supplies of bread in the shops.

Information shared by Soviet and Alaskan agriculture researchers was used to indicate the high storage losses and single use of potatoes in the Soviet Far East and Alaska.

The indicators of problems in the two areas (bread and potatoes) lead to a strategy for designing a solution that combined the two problems. The strategy for solving the problems included:

1. Pilot study experimentation to determine the levels of replacement and the form of potatoes to be used as a substitute for wheat flour in bread;

2. Consumer laboratory acceptance testing and descriptive analysis of the potato bread variations;

3. Central location consumer testing in the Soviet Far East and Alaska;

4. Objective measures of the bread products that focused on the shelf-life of the experimental potato breads.

The results of the research became the indicators of progress toward the goal.

In the potato bread research the problem definition was not a collaborative process. Input from individuals from different groups was sought but the problem definition, indicators, and goals were essentially defined by one or two individuals. In the implicit design the user was viewed as a recipient of the knowledge and information gained by the specialist. A negative result of the implicit process was a lack of understanding of Soviet users power to make choices. In the large commercial bakery in Magadan, the baker cannot make the choice to change bread ingredients or recipes, this had a direct impact on the ability of the strategy chosen to solve the problem. Essentially, the solution was not acceptable, at this point in time, for solving the problem as it had been defined. Increasing user participation in the problem definition process and viewing the user as a resource, may have resulted in a different strategy for solving the problem.

4.04c The Solution Process

Emerging from the problem definition process, specifically from the determination of indicators, is the solution process. The major components of the solution process are: 1) developing alternatives, 2) testing, adaptation, and evaluation, and 3) diffusion.

Alternative solutions developed for this research focused on variations in the amount of potato that would substitute for wheat flour in bread. The potato bread solution also considered minimal processing of the potato as a positive factor in developing the bread products, so boiled potatoes and potato flakes were used.

Testing, adaptation, and evaluation of the products were carried out in several environments: the foods laboratory at Virginia Tech, and in urban and rural locations in Alaska and the Soviet Far East. Experimental work with various levels of replacement of potato for wheat flour indicated that the potato bread products could be produced. Adaptation of the boiled-mashed potato bread recipe in Anadyr, USSR indicated the bread formula could be adjusted based on the potato source. Objective evaluation of the bread products indicated that addition of potato extended the shelf-life of the loaf. Sensory evaluation of the potato bread products indicated that consumers in all locations found the potato bread solution acceptable and that consumers would buy the product if it was available.

Diffusion of the potato bread solution occurred in the implicit model as a result of the testing, adaptation, and evaluation component. Users involved in the central location acceptance tests, the baker that was interviewed, and Soviet specialists involved in assisting with the testing were exposed to the potato bread products.

In a collaborative process the solutions to problems are not prescribed by a specialist but arise from the knowledge and previous experience contributed by specialists and policy makers, and the local knowledge and experience of the users. Future research would benefit if the solution process were sensitive to the needs, preferences, and concerns of the collaborators.

4.04d Collaborative Development Process Summary

The collaborative development process identifies three major components; the people involved, the problem defined, and the solution process. The lack of a collaborative group of specialists, users, and policy makers, who could shepherd the research through the problem definition and solution processes was the weak component of the implicit model. As the Soviet system and society rapidly change, the importance of the collaborator role increases. Involving people who are able define the problems and evaluate and adapt potential solutions in relation to the needs of the users will be critical.

In spite of this shortcoming, the potato bread research indicated that Soviet citizens are interested in consumer research and are willing to participate in the development process. Evaluation of the implicit collaborative development process indicated the model may be useful in the Soviet culture. The research also indicated a consumer acceptance of potato products as a substitute for wheat flour in breads.

CHAPTER V

CONCLUSIONS

The conclusions of this study were:

1. Pilot Studies. The results of the pilot studies did not assist in choosing specific bread products for central location acceptance testing. Although all the scoring of the bread products indicated that panelist liked the breads, there was no significant difference in the degree of liking among breads. Panelist judged the bread variations with added gluten as similar in acceptance to the breads without gluten.

2. Objective Evaluation of Breads:

a. Volume. Statistical analysis indicated the standing heights of the breads were not significantly different.

b. Cell Size. Generally, when the potato replacement exceeded 15%, the texture of the bread was open, with irregular and large cells formed by trapped leavening gases.

c. Moisture. There was a significant difference among the breads in moisture percent loss. The 45% Idaho potato bread had the highest moisture content (50.41%) and the second lowest total moisture percent loss (3.60%) over four days.

d. Protein and Amino Acid Contents. On a dry weight basis, the protein content of the 15% potato flake and 45% Idaho potato breads were slightly higher than the control "rapid" and 100% Soviet flour breads. Except for small variations, the amino acid contents of the five breads were similar.

e. Analysis of Freshness. The analysis of freshness data showed rapid increases in the texture measurements (grams of force) of the breads between days 1 and 4. The 45% Idaho potato bread had the highest texture measurements from the day of baking through day 4.

f. Staling. The control "rapid" and 100% Soviet flour breads had the highest staling measurements (area/mg) and were not significantly different from each other in the total amount of staling that occurred during the fourteen days. The 15% potato flake, 45% Idaho potato, and 29% Red potato breads had significantly lower staling measurements than the control "rapid" and 100% Soviet flour breads.

3. <u>Sensory Evaluation of Bread Products</u>.

a. QDA. In general, the 100% wheat flour and potato bread products evaluated by the QDA panelists would be characterized as similar in sensory qualities. The addition of potato products to breads as a means of extending the supply of flour would yield a bread product similar in sensory characteristics to 100% wheat four bread. If consumers are able to detect the higher moisture content of potato breads without characterizing the bread as "different" in other characteristics from non-potato bread, the consumer would benefit from the perception, as well as the actuality, of longer shelf-life.

b. Central Location Acceptance Tests. The central location acceptance tests indicated that consumers in one USA community and in three USSR communities liked the potato breads and the 100% wheat flour bread (control "rapid") baked in the home bakery appliance more than the locally purchased, commercially baked bread. The potato breads and the control "rapid" bread were equally acceptable to consumers.

c. Central Location Acceptance Test Survey. The responses to the survey questionnaire indicated that 50% or more of the consumers responding liked the potato bread products the most. The control "commercial" bread was consistently chosen as the bread liked the least in all locations. If the breads liked most by consumers were available in the store, consumers indicated they would buy the bread.

4. Collaborative Development Process. The potato bread research indicated that Soviet citizens were interested in consumer research and were willing to participate in a development process. Evaluation of the implicit collaborative process indicated the model may be useful in food research in the Soviet society in the future.

CHAPTER VI

SUGGESTIONS FOR FURTHER RESEARCH

The purpose of this research was to incorporate an underutilized, accessible product as a partial replacement for an imported product in a staple food such as bread and to define a collaborative process for the development of the food product in international communities.

Future research in three areas would be suggested:

1. Consumer research methodologies in international settings; are focus group and sensory evaluation methods sensitive to changes in culture?
2. Role of bread in the Soviet diet; the amount of bread produced is known, but how much bread is actually consumed and how is it used in the daily meals?
3. Application of a collaborative development process to food product development; is a collaborative development process a realistic model for the design of food product research in international settings?
4. Is the commercial production of potato bread products feasible?

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APPENDIX 3.01h(i)

CHARACTERISTICS OF POTATO VARIETIES

To Dr.D.Carling

Characteristics of potato varieties

N\N n\n	VARIETY	maturity	The colour of: skin	flesh	flower	tuber form	shallowness of eyes	starch cont	cooking qualities	drought tolerance	resistance to: wart	scab com	viruses	blight: leaf	blight: tuber	black leg
1	Bieloruskii rannii	1	w	w	w	or	5	12-17	7	5	R	6	4-5	3	5	3
2	Sedov	1	w	w	w	or	5	10-13	5-7	9	S	4	8	1-3	1-3	1-3
3	Nevskii	2	w/v	w	w	ro	7-9	11-13	5	7	R	6	6-7	6	6	5
4	Kemerovskii	2	w	w	w	o	5-6	15-20	5	9	S	5	8	1-3	1-3	7
5	Kameraz	3(2)	w	w	w	or	7	15-17	6	7	R	6	7	5	5-7	5
6	Preobskii	2	w	w	w	lo	6-7	12-16	7	5	S	4	6	3	1-3	7
7	Prejekulskii ranii	1	w	w	w	or	6	10-17	5	5	R	5	5	1-3	1-3	3
8	Berlichingen	4	r	w	rv	o	6-7	15-22	5	6	R	7	6	3	3	5
9	Yermak	1-2.	lr	w/a	rv	or	7-9	13-15	7	7	S	7	5-6	1-3	3	1-3
10	Adretta	2	w	y	w	or	7	15-18	9	7-6	R	7	6	1-3	1-3	1
11	Utro omskoie	3	w	w	w	ro	7	12-18	6	7	R	7	6	1-3	1-3	7
12	Bielosniezhka omskaia	1-2	w	w	w	o	6	12-14	5	7-8	R	5	7	1-3	1-3	3
13	Narimka	2	w	w	rv	ro	5-6	13	5-6	5-6	R	5	3	3	3	3
14	Poliot	1	r	w	w	o	6	11-13	5	6	R	6	6	1-3	1-3	3
15	Syr-9	2	w	ly	w	ro	6	18-21	7-8	6	R	--	6	3	3	--
16	Bielojarskii	2	lr	w	w	ro	6	14-15	7	6	R	--	4	5	5	--

Notes:

- maturity: 1 - early, 9 - late
- colour(of skin, flesh, flower): w - white; w/v - white tubers, light -violet eyes; r - red; lr - light red; w/a - white flesh and antociane spots sometime; y - yellow; ly - light yellow; rv - red violet.
- tuber form: or - oval-round; ro - round-oval; o - oval; lo - long-oval.
- shallowness of eyes: 5 -mid-deep; 9 - superficial.
- starch content: in percents.
- cooking qualities: 5 - reasonable; 9 - very good.
- drought tolerance, resistance: 1 - succeptible; 9 - resistant.
- wart resistance: R - resistant; S - succeptible.

APPENDIX 3.01h(ii)

PREPARATION METHOD FOR BOILED-MASHED POTATOES

BOILED-MASHED POTATOES

Russet Burbank, Red La Soda, Red Pontiac, Prejekulskii ranii

1. Peel Russet Burbank potatoes and cut into approximately 4.0 cm cubes.

1a. Do not peel Red La Soda, Red Pontiac, and Prejekulskii ranii and leave whole or cut into pieces approximately 4.0 cm X 4.0 cm.

2. Place potatoes in a pan with enough water to cover.

3. Boil gently until fork tender but still firm; approximately 20 minutes for 3 medium sized potatoes.

4. Drain and cool potatoes completely. Potatoes must be cool before mashing with a fork.

APPENDIX 3.01i

VITAL WHEAT GLUTEN
RAW MATERIAL SPECIFICATION

Date	WATSON FOODS CO., INC.	Spec. No.
July 1989	Raw Material Specification	3-1003
Page		Replaces No.
1 of 1	VITAL WHEAT GLUTEN	Original

DESCRIPTION
A free-flowing powder source of protein-rich wheat gluten.

PROPERTIES

Color	cream
Odor	none
Moisture	8% maximum
Granulation	100% thru USS No.45 95% min. thru USS No.80 20% max. on USS No.140 80% min. on USS No.200
pH	6-7
Bulk Density	42 lbs./ft^3 (packed)

ASSAY

Protein	75% minimum
Ash	1% maximum
Fat	2.5% maximum

MICROBIOLOGICAL DATA
Good manufacturing practices.

FUNCTION
For use in the bakery industry as a dough strengthener and enhancer.

F.D.A. STATUS
Complies with current G.R.A.S. specifications.

PACKAGING
50-100 lbs. net weight in multiwall paper bags with a polyethylene lining.

LABELING
Bags must be legibly marked with the product name, net weight, lot number, and the manufacturer's date.

SHIPPING AND STORAGE CONDITIONS
This product must be shipped and stored in a sanitary manner, preferably at 70°F and 50% R.H.

QUALITY ASSURANCE
It is the supplier's responsibility to assure that their product meets these specifications.

APPENDIX 3.01j

TECHNIQUES FOR MEASURING INGREDIENTS

TECHNIQUES FOR MEASURING INGREDIENTS

The following procedures for measuring ingredients were developed to reduce variability in the bread products baked for the central location acceptance tests. These procedures were practiced in a lab setting, where ingredients were measured in metric measuring cups or spoons and then weighed, until the constant range of variation was established. The smaller the unit of measurement, the greater the variation, so measuring in spoons was more variable than measuring in cups. The boiled-mashed potatoes and potato flakes were the most difficult to measure consistently. Flour, sugar, dry milk, yeast, and gluten showed less variability when using volume measurements.

1. Potato Flakes and Boiled-Mashed Potatoes

The potato flakes were tossed and stirred 50 times prior to gently spooning into metric cups or spoons. Care was taken to avoid packing down the potato flakes, since over- filling the metric measures was the primary source of variation. A metal lab spatula was used to level off the potato flakes. The potato flakes were lightly tossed with the flour an additional 50 times.

The cool boiled-mashed potatoes were peeled, and cut into smaller pieces. The pieces were placed on a plate and mashed with a fork. The mashed potato was layered into the measuring utensil without packing down the layers. The mashed potato was added to the flour and cut in with a fork until the texture was uniform.

2. Flour, Dry Milk, Gluten, Sugar and Yeast

The flour, dry milk, and gluten were all stirred and tossed with a fork 50 times prior to gently spooning into metric cups, spoons or the Hitachi measuring utensil. The sugar and yeast were spooned or poured directly into the measuring utensil. A metal lab spatula was used to level off the ingredients. The flour and potato products were mixed together and then the dry milk, gluten (15% replacement bread only) and sugar were added and lightly tossed 50 times.
The yeast was not mixed in with the other ingredients. It was measured, and added last, in the home bakery appliance bread pan.

3. Margarine or Butter

The margarine or butter were solid and cool when measured in the home bakery appliance measuring utensil.

APPENDIX 3.02d

HITACHI HOME BAKERY APPLIANCE

AND

MAGNETECH JEFFERSON ELECTRIC STEPDOWN TRANSFORMER

HITACHI HOME BAKERY APPLIANCE AND TRANSFORMER
IN ANADYR, USSR

APPENDIX 3.03b(i)

PILOT STUDY 2, ACCEPTANCE SCORESHEET

PILOT STUDY 2
ACCEPTANCE SCORESHEET

PANELIST NUMBER ________________ DATE ______________________

Please taste these bread samples and indicate how much you like or dislike each one. Make a vertical line (/) through the horizontal line (__/__) for each sample to show your rating.

Sample ________

___/_______________________________/___
dislike very much　　　　like very much

Sample ________

___/_______________________________/___
dislike very much　　　　like very much

Sample ________

___/_______________________________/___
dislike very much　　　　like very much

Sample ________

___/_______________________________/___
dislike very much　　　　like very much

COMMENTS: ___________________________________

____

____

____

____ THANK YOU.

APPENDIX 3.03b(ii)

EVALUATION OF SEVEN POINT HEDONIC SCALES
SCORESHEET

PANELIST NUMBER______________//______________DATE July 10, 1990

PRODUCT Bread

Please taste these samples and show how much you like or dislike each one. Mark an "X" on the line scale to show your rating.

Example: Dislike ___:___:___:_X_:___:___:___ Like

Sample 010

1 2 3 4 5 6 7

Dislike ___:___:___:___:___:___:___ Like

Sample 773

-1 -2 -3 0 +1 +2 +3

Dislike ___:___:___:___:___:___:___ Like

If you were taste testing for the first time, which line scale would be easier to understand and to use? Please mark one answer and write down any comments or suggestions.

The line scale for sample 010 is easier. _____

The line scale for sample 773 is easier. _____

Comments ____

____

____

____

____ Thank you.

APPENDICES 3.03b(iii) AND 3.03b(iv)

CENTRAL LOCATION ACCEPTANCE TESTS
SCORESHEETS (ENGLISH AND RUSSIAN)

NUMBER __________ DATE _____________ PRODUCT __Bread__

Please taste these bread samples and show how much you like or dislike each one. Mark an _X__ on the line scale to show your rating.

1 2 3 4 5 6 7
[Example: Dislike___:___:___:_X_:___:___:___ Like]

Sample

1 2 3 4 5 6 7
Dislike___:___:___:___:___:___:___ Like

Sample _

1 2 3 4 5 6 7
Dislike___:___:___:___:___:___:___ Like

Sample _

1 2 3 4 5 6 7
Dislike___:___:___:___:___:___:___ Like

Sample _

1 2 3 4 5 6 7
Dislike___:___:___:___:___:___:___ Like

Comments ____
____
____
____
____
____ Thank you .

Номер ; ________ Число: ____________ Продукт : Хлеб ____________

~~Попробуйте эти образцы хлеба и укажите, как каждый Вам по вкусу. Отметьте крестиком X на линейке Вашу оценку.~~

[Пример: Не нравится 1 ___ : 2 ___ : 3 ___ : 4 X : 5 ___ : 6 ___ : 7 ___ Нравится]

Образец

Не нравится 1 ___ : 2 ___ : 3 ___ : 4 ___ : 5 ___ : 6 ___ : 7 ___ Нравится

Образец

Не нравится 1 ___ : 2 ___ : 3 ___ : 4 ___ : 5 ___ : 6 ___ : 7 ___ Нравится

Образец

Не нравится 1 ___ : 2 ___ : 3 ___ : 4 ___ : 5 ___ : 6 ___ : 7 ___ Нравится

Образец

Не нравится 1 ___ : 2 ___ : 3 ___ : 4 ___ : 5 ___ : 6 ___ : 7 ___ Нравится

Замечания: ____

Благодарим!

APPENDIX 3.03b(v)

SURVEY QUESTIONS TO ACCOMPANY CENTRAL LOCATION ACCEPTANCE TESTS

SURVEY QUESTIONS PREFERENCE TESTING

Ask every third person if they would answer some additional questions about the bread they have sampled. We would like to understand why they liked/disliked the samples of bread. The questions will be asked verbally and it will take 5 to 10 minutes to answer the questions. Tell the person we would like to tape record their answers and also make notes on their answers.

1. Which bread sample did you like the most?

   Sample number ______________________________

2. Describe what you liked about this bread sample.

   a.

   b.

   c.

3. Which bread sample did you like the least?

   Sample number ______________________________

4. Describe what you disliked about this bread sample.

   a.

   b.

   c.

5. If the bread you liked the most was available in a store, would you buy it?

   yes________ no________

6. Would you buy the bread sample you liked most instead of the bread you usually buy?

   yes________ no________

7. Do you have other comments about the bread samples that you would like to share?

   a.

   b.

8. Location/community ____

APPENDICES 3.05b(i) and 3.05b(ii)

QDA SCORESHEET AND BREAD CHARACTERISTIC REFERENCE SHEET

QDA-Bread
Scoresheet

SAMPLE ____________________

1. Crust Color

Light — Dark

2. Cell Size

Small — Large

3. Cell Uniformity

Less — More

4. Crumbly

Less — More

5. Moisture

Less — More

6. Potato Flavor

______/____/______

Mild Strong

7. Chewiness

______/____/______

Less More

8. Adhesiveness

______/____/______

Less More

9. Aftertaste

______/____/______

Mild Strong

10. Crust Hardness

______/____/______

Soft Hard

COMMENTS:

BREAD CHARACTERISTICS
DEFINITIONS/REFERENCES

1. Crust Color: **Medium** would be similar to the molasses whole wheat bread.

2. Cell Size: **Small** would be similar to the cell size of the cells close to the crust on the molasses whole wheat bread. Wonder Bread would also have a small cell size.

3. Cell Uniformity: **Less** would be similar to a French/Italian bread (also see sample of potato sourdough bread). **Medium** would be similar to the molasses whole wheat bread. **More** would be like Wonder Bread.

4. Crumbly: **Less** would be similar to Wonder Bread. **Medium** would be like the molasses whole wheat bread. **More** would be like a multi-grain bread (try sample during practice).

5. Moisture: **Less** would be like a high fiber or multi-grain bread. **Medium** would be like the molasses whole wheat bread. **More** would be like Wonder Bread.

6. Potato Flavor: **None** mark at end of line, to the left of the anchor word. **Mild** would be just able to taste some potato. **Strong** would be like mashed potatoes.

7. Chewiness: **Less** would be like a biscuit. **More** would be like French bread or bagels.

8. Adhesiveness: **Less** would be like jelly. **More** would be like peanut butter.

9. Aftertaste: Any undesirable (??) taste left in mouth immediately after swallowing.

10. Crust Hardness: **Medium** would be similar to the molasses whole wheat bread. **Hard** would be like crusty french bread.

APPENDIX 3.06b(i)

CENTRAL LOCATION ACCEPTANCE TESTS
JUNEAU, ALASKA USA
ANADYR, MAGADAN, AND OLA USSR
MAP

MAPS, USA AND USSR

APPENDIX 3.06b(ii)

CENTRAL LOCATION ACCEPTANCE TESTS
BREAD RECIPES

100% WHEAT BREAD FLOUR
RAPID BREAD RECIPE

INGREDIENTS	VOLUME (ml)	WEIGHT (g)
Water	270	
Flour	750 (3-250 ml cups)	375.0
Salt	3 (1-1/2 "S" spoons or 3/4-teaspoon)*	6.4
Sugar	45 (3 "L" spoons or 3-Tablespoons)	37.3
Dry Milk	22.5 (1-1/2 "L" spoons or 1-1/2Tablespoons)	7.6
Butter/Margarine	22.5 (1-1/2 "L" spoons or 1-1/2 Tablespoons)	18.4
Dry Yeast	10.0 (2 "M" spoons or 2 Teaspoons)	6.0

1. Attach blade to home bakery appliance bread pan.
2. Measure water into bread pan.
3. Into a mixing bowl measure: bread flour, salt, sugar, and dry milk. Stir and toss 50 times with a fork.
4. Add flour mixture to water in bread pan.
5. Measure and add butter/margarine.
6. Measure and add yeast.
7. Place bread pan in bakery, close lid, plug into outlet or transformer, program for "Rapid Bread", start, and lock.
8. When buzzer sounds (2 hours and 50 minutes), remove bread from pan and place on cooling rack. Cool completely (at least 2 hours), then place in plastic bag or wrap with plastic. Label.

* "S", "M", and "L" spoons are the designation given to the Hitachi home bakery appliance measuring utensil.

15% REPLACEMENT (BY WEIGHT) OF WHEAT FLOUR WITH POTATO FLAKES WITH ADDED GLUTEN

INGREDIENTS	VOLUME (ml)		WEIGHT (g)
Water	285		
Flour	550	(2-250 ml cups, 1- 50 ml cup)	275.9
Potato Flakes	200	(1-125 ml cup, 1- 50 ml cup, 1- 25 ml spoon)	42.8
Gluten	15	(1 "L" spoon or 1 Tablespoon)*	7.5
Salt	3	(1-1/2 "S" spoons or 3/4 teaspoon)	6.4
Sugar 31.1	37.5	(2-1/2 "L" spoons or 2-1/2 Tablespoons)	
Dry Milk	22.5	(1-1/2 "L" spoons or 1-1/2 Tablespoons)	7.6
Butter/Margarine	22.5	(1-1/2 "L" spoons or 1-1/2 Tablespoons)	18.4
Dry Yeast	7.5	(1-1/2 "M" spoons or	4.8

1. Attach blade to home bakery appliance bread pan.
2. Measure water into bread pan.
3. Into a mixing bowl measure: bread flour and potato flakes. Stir and toss 50 times.
4. Add gluten, salt, sugar and dry milk to mixing bowl. Stir and toss 50 times.
5. Add flour mixture to water in bread pan.
6. Measure and add butter/margarine.
7. Measure and add yeast.
8. Place bread pan in bakery, close lid, plug into outlet or transformer, program for "Rapid Bread", start and lock.
9. When buzzer sounds (2 hours and 50 minutes), remove bread from pan and place on cooling rack. Cool completely (at least 2 hours), then place in plastic bag or wrap with plastic. Label.

* "S", "M", and "L" spoons are the designation given to the Hitachi home bakery appliance measuring utensil.

29% REPLACEMENT (BY WEIGHT) OF WHEAT FLOUR WITH BOILED-MASHED RED POTATOES

INGREDIENTS	VOLUME (ml)		WEIGHT (g)
Water	200		
Flour	625	(2-250 ml cups, 1-125 ml cup)	314.9
Boiled-mashed potatoes	125	(1-125 ml cup)	91.3
Salt	3	(1-1/2 "S" spoons or 3/4 teaspoons)*	6.4
Sugar	45	(3 "L" spoons or 3 Tablespoons)	37.3
Dry Milk	22.5	(1-1/2 "L" spoons or 1-1/2 Tablespoons)	7.6
Butter/Margarine	22.5	(1-1/2 "L" spoons or 1-1/2 Tablespoons)	18.4
Dry Yeast	10	(2 "M" spoons or 2 teaspoons)	6.0

1. Attach blade to home bakery appliance bread pan.
2. Measure water into bread pan.
3. Into a mixing bowl measure: flour, salt, sugar, and dry milk. Stir and toss 50 times with a fork.
4. Peel and break up, completely cool, red potatoes. In a bowl or on a plate mash the potatoes with a fork.
5. Cut potatoes into flour mixture until texture is uniform.
6. Add flour mixture to water in bread pan.
7. Measure and add butter/margarine.
8. Measure and add yeast.
9. Place bread pan in bakery, close lid, plug into outlet or transformer, program for "Rapid Bread", start and lock.
10. When buzzer sounds (2 hours and 50 minutes), remove bread from pan and place on cooling rack. Cool completely (at least 2 hours), then place in plastic bag or wrap with plastic. Label.

* "S", "M", and "L" spoons are the designation given to the Hitachi home bakery appliance measuring utensil.

45% REPLACEMENT (BY WEIGHT) OF WHEAT FLOUR WITH BOILED-MASHED IDAHO POTATOES

INGREDIENTS	VOLUME (ml)		WEIGHT (g)
Water	207		
Flour	575	(2-250 ml cups, 1- 50 ml cup, 1- 25 ml spoon)	287.8
Boiled-mashed Idaho potatoes	175	(1-125 ml cup, 1- 50 ml cup)	130.1
Salt	3	(1-1/2 "S" spoons or 1-1/2 teaspoons)*	6.4
Sugar	30	(2 "L" spoons or 2 Tablespoons)	24.8
Dry Milk	22.5	(1-1/2 "L" spoons or 1-1/2 Tablespoons)	7.6
Butter/Margarine	22.5	(1-1/2 "L" spoons or 1-1/2 Tablespoons)	18.4
Dry Yeast	7.5	(1-1/4 "M" spoons or 1-1/4 teaspoons)	4.0

1. Attach blade to home bakery appliance bread pan.
2. Measure water into bread pan.
3. Into a mixing bowl measure: flour, salt, sugar, and dry milk. Stir and toss 50 times with a fork.
4. Break up completely cool Idaho potatoes. In a bowl, or on a plate mash the potatoes with a fork.
5. Cut potatoes into flour mixture until texture is uniform.
6. Add flour mixture to water in bread pan.
7. Measure and add butter/margarine.
8. Measure and add yeast.
9. Place bread pan in bakery, close lid, plug into outlet or transformer, program for "Rapid Bread", start and lock.
10. When buzzer sounds (2 hours and 50 minutes), remove bread from pan and place on cooling rack. Cool completely (at least 2 hours), then place in plastic bag or wrap with plastic. Label.

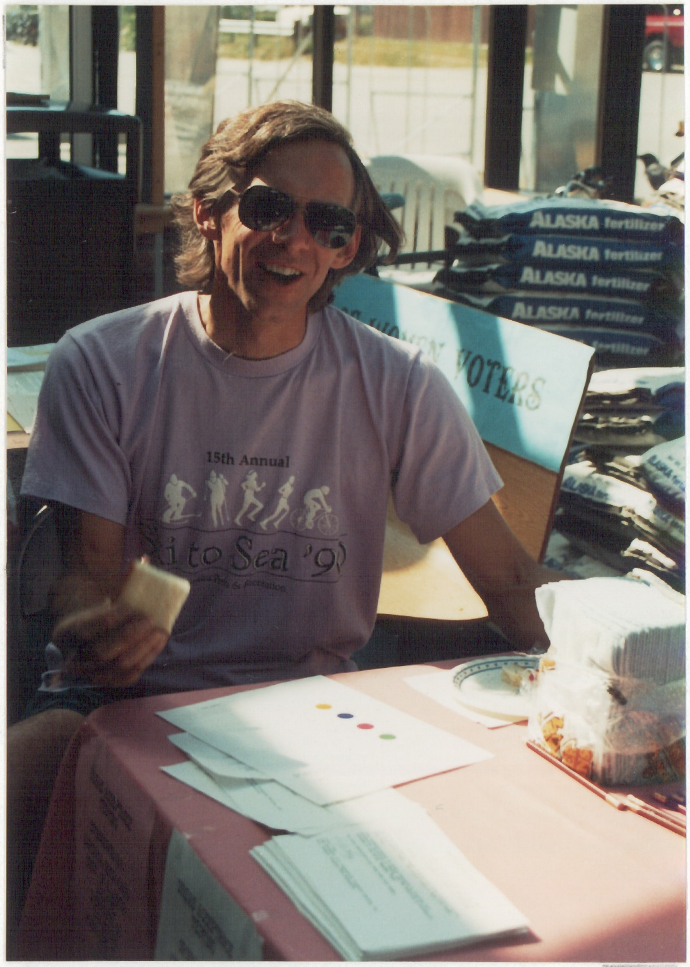
* "S", "M", and "L" spoons are the designation given to the Hitachi home bakery appliance measuring utensil.

APPENDIX 3.06b(iii)

CENTRAL LOCATION ACCEPTANCE TEST

JUNEAU, ALASKA

FOOD LAND SUPERMARKET ENTRY
JUNEAU, ALASKA
FRIDAY, JULY 20, 1990



APPENDIX 3.06c(i)

CENTRAL LOCATION TEST

ANADYR, USSR

ANADYR RESTAURANT
FRIDAY, JULY 27, 1990

APPENDIX 3.06d(i)

CENTRAL LOCATION ACCEPTANCE TEST

MAGADAN, USSR

CONFERENCE ROOM
INSTITUTE OF BIOLOGICAL PROBLEMS OF THE NORTH
MAGADAN, USSR

APPENDIX 3.06e(i)

CENTRAL LOCATION ACCEPTANCE TEST

OLA, USSR

OLA HOSPITAL
MONDAY AUGUST 6, 1990

APPENDIX 4.03c

SURVEY QUESTIONS ACCEPTANCE TESTING RESPONSES

SURVEY QUESTIONS ACCEPTANCE TESTING

RESPONSES

1. Which bread sample did you like the most?

Location	Subject	Response(s)
1	1	Control "Rapid"
1	2	15% Potato Flake, Control "Rapid"
1	3	Control "Rapid"
1	4	All 4 breads
1	5	Control "Rapid"
1	6	Control "Rapid"
1	7	45% Idaho Potato
1	8	45% Idaho Potato
1	9	15% Potato Flake
1	10	15% Potato Flake, Control "Commercial" Control "Rapid"
1	11	15% Potato Flake
1	12	15% Potato Flake
2	1	Control "Commercial"
2	2	29% Red Potato Control "Rapid" 15% Potato Flake
2	3	15% Potato Flake
2	4	29% Red Potato
2	5	Control "Rapid"
2	6	Control "Rapid"
3	1	15% Potato Flake
3	2	Control "Rapid", 15% Potato Flake, 29% Red Potato
3	3	Control "Rapid"
3	4	Control "Rapid" 29% Red Potato
3	5	15% Potato Flake
3	6	Control "Rapid" 29% Red Potato 15% Potato Flake
3	7	29% Red Potato Control "Rapid"
3	8	15% Potato Flake
3	9	Control "Rapid"
3	10	15% Potato Flake Control Commercial
3	11	Control Commercial

3	12	15% Potato Flake
4	1	Control Commercial
4	2	29% Red Potato, 15% Potato Flake
4	3	Control commercial, 29% Red Potato, Control "Rapid"
4	4	29% Red Potato
4	5	15% Potato Flake 29% Red Potato
4	6	Control "Rapid"

2. Describe what you liked about this bread sample.

Location	Bread Liked	Responses
1	Control "Rapid"	texture: chewy, more flavor, sweeter, heavier, taste, didn't taste salty, tasted like homemade
2	Control "Rapid"	airy, the tenderness, taste, aromatic, like homemade bread, porous
3	Control "Rapid"	taste: sweet, consistency: porous (2), flavor, airy (2), aromatic (4), soft, very tasty,
4	Control "Rapid"	tasty, good with tea, like bun
1	15% Potato Flake	more chewy, liked texture and taste, not too sweet, Control "rapid" and 45% have same taste, moist, tasted good, nothing special, taste, flavor, heavier, tastier tasted like homemade,
2	15% Potato Flake	pleasant color, porous,
3	15% Potato Flake	aromatic, soft (2), tender, airy, it's good and that's all, taste (2),

		flavor,
4	15% Potato Flake	sweet, like bun

1	45% Idaho Potato	taste, flavor: sourdough, tasted best, not as heavy, lighter
2	29% Red Potato	taste, porous, aromatic, like good homemade bread
3	29% Red Potato	airy, aromatic
4	29% Red Potato	porous, aromatic
1	Control Commercial	no responses
2	Control Commercial	tasty, soft, porous
3	Control Commercial	like coarse bread
4	Control Commercial	it's more customary, aromatic

The following responses are from people who chose more than one bread as the one they liked most. The bread listed first and comments are duplicated in the preceding section.

1	(Like all breads)	texture, taste, sensation in mouth,
1	15% Potato Flake + Control "Rapid"	flavor, heavier, tastier tasted like homemade,
1	15% Potato Flake, +Control Commercial, +Control Rapid	nothing special
2	29% Red Potato, +Control "Rapid", +15% Potato Flake	taste, porous
3	29% Red Potato, + Control "Rapid"	airy, aromatic

3	15% Potato Flake, +Control Commercial	taste
3	Control "Rapid", +15% Potato Flake, +29% Red Potato	it's very tasty, aromatic, porous
3	Control "Rapid", +29% Red Potato	airy, aromatic
3	Control "Rapid" +29% Red Potato, +15% Potato Flake	airy, aromatic
4	29% Red Potato, +15% Potato Flake	porous, aromatic
4	Control Commercial, +29% Red Potato, +Control "Rapid"	like the sweet bread
4	15% Potato Flake, + 29% Red Potato	sweet like bun

3. Which bread sample did you like the least?

Location	Responses
1	Control "Commercial"
1	Control "Commercial"
1	Control "Commercial"
1	Control "Commercial"
1	Control "Commercial"
1	Control "Commercial"
1	Control "Commercial"
1	Control "Commercial"
1	Control "Rapid"
1	Control "Rapid", 15% Potato Flake
1	45% Idaho Potato
1	all the same bread
2	Control "Commercial"
2	Control "Commercial"
2	Control "Commercial"
2	Control "Commercial"
2	Control "Commercial"
2	15% Potato Flake
3	Control "Commercial"
3	Control "Commercial"
3	Control "Commercial"
3	Control "Commercial"
3	Control "Commercial"
3	Control "Commercial"
3	Control "Commercial", 29% Red Potato
3	Control "Commercial"
3	Control "Commercial"
3	29% Red Potato, Control "Commercial"
3	29% Red Potato
3	15% Potato Flake
4	everything is good
4	Control "Rapid"
4	15% Potato Flake
4	Control "Commercial"
4	Control "Commercial"
4	15% Potato Flake, Control "Commercial"

4. Describe what you disliked about this bread sample.

Location	Bread Disliked	Responses
1	all same	no response
1	Control "Commercial" +15% Potato Flake	texture too light, wasn't whole grain, no taste
1	Control "Commercial"	commercial, no flavor
1	Control "Commercial"	taste-tasted yeasty
1	Control "Commercial"	salty taste
1	Control "Commercial"	not enough taste, not as heavy as would like
1	Control "Commercial"	taste, too light
1	Control "Commercial"	taste
1	Control "Commercial"	"Wonder-bread-like", tasted doughy
1	Control "Rapid"	dry
1	Control "Rapid" + 15% Potato Flake	bland, heavier
1	45% Idaho Potato	flavor
2	Control "Commercial"	coarse
2	Control "Commercial"	coarse, little sour
2	Control "Commercial"	coarse, little sour
2	Control "Commercial"	stale
2	Control "Commercial"	coarse, unleavened
2	15% Potato Flake	it's bady baked
3	Control "Commercial"	coarse, not fresh
3	Control "Commercial"	coarse, not porous
3	Control "Commercial"	little unleavened
3	Control "Commercial"	sourish, dry, could be bought at local bakery
3	Control "Commercial"	it's usual bread
3	Control "Commercial"	stale, not aromatic
3	Control "Commercial" +29% Red Potato	no response
3	Control "Commercial"	little unleavened
3	Control "Commercial"	taste
3	29% Red Potato, + Control "Rapid"	not so delicious

3	29% Red Potato	bread sample not bad just do not like bread like that,
3	15% Potato Flake	unleavened
4	everything good	no response
4	Control "Rapid"	tasteless
4	15% Potato Flake	little sour
4	Control "Commercial"	unleavened
4	Control "Commercial"	it's good with soup
4	15% Potato Flake, + Control "Commercial"	it's good with soup

5. If the bread you like the most was available in a store, would you buy it?

Location	Yes	No
1	no response	no response
1	X (15% Potato Flake)	
1	X (15% Potato Flake)	
1	X (15% Potato Flake)	
1	X (15% Potato Flake)	
1	occasionaly (15%)	
1	X (Control Rapid)	
1	X (Control Rapid)	
1		X (45% Idaho Potato)
1	X (Control Rapid)	
1		X (45% Idaho Potato)
1	X (Control Rapid)	
2		X (29% Red Potato)
2	X (Control Rapid)	
2	X (Control Rapid)	
2	X (15% Potato Flake)	
2	X (29% Red Potato)	
2	X (Contro Commercial)	
3	X (Control Commercial)	
3	X (15% Potato Flake)	
3	X (15% Potato Flake)	
3	X (Contro Rapid)	
3	NO RESPONSE	NO RESPONSE
3	X (Control Rapid)	
3	X (15% Potato Flake)	
3	X (15% Potato Flake)	
3	X (15% Potato Flake)	
3	X (Control Rapid)	
3	X (Control Rapid)	
3	X (29% Red Potato)	
4	X (Control Commercial)	
4	X (29% Red Potato)	
4	X (Control Commercial)	
4	X (29% Red Potato)	
4	X (15% Potato Flake)	
4	X (Control Rapid)	

6. Would you buy the bread sample you liked most instead of the bread you usually buy?

Location	Yes	No
1	no response	no response
1		X
1		X
1	X (DEPENDS ON PRICE)	
1		X (MAKE OWN BREAD)
1	X (IF ORGANIC)	
1	X	
1	X	
1	NO RESPONSE	NO RESPONSE
1	X	
1		X (DON'T BUY BREAD)
1		X
2	NO RESPONSE	NO RESPONSE
2	X	
2	X (A FAVORITE SORT)	
2	X	
2	X	
2	X (CC)	
3	THIS QUESTION WAS NOT ANSWERED IN MAGADAN	
4	THIS QUESTION WAS NOT ANSWERED IN OLA	

7. Do you have other comments about the bread samples that you would like to share?

Location	Comments
1	tasted same, enjoyed all
1	45% Idaho potato bread tasted salty
1	45% Idaho potato bread good, would buy it too, it's heavier
1	liked variety of bread, liked the breads
1	tasted homemade
1	tasted good
1	should have beer
1	liked color; don't like white bread
2	I like the heavy density bread, especiall black bread
2	it's very fresh and soft
2	thank you very much!
2	thank you very much!
3	thank you
3	it will be good to have this bread in Magadan
3	very tasty
3	all the samples are wonderful
4	very good with tea

VITA

Kristine Long was born January 6, 1950 in Seattle, Washington. She attended elementary and high school in San Anselmo, California and received her Bachelor of Science degree in Home Economics education from California Polytechnic State University, San Luis Obispo, in 1972. While finishing the requirements for a California secondary teaching credential the author entered the Peace Corps and taught Home Economics at Tonga High School and assisted the Ministry of Education in curriculum development, in Nuku'alofa, Tonga.

Since 1977, the author has been an Extension faculty member of the University of Alaska. She has been stationed in Nome and in Ketchikan. The author received sabbatical leave in 1983, to attend Virginia Tech where she earned a Master of Science degree from the Department of Human Nutrition and Foods in 1985. In 1989, the author was granted a leave of absence from the University of Alaska to enter the doctoral program in the Department of Human Nutrition and Foods at Virginia Tech. The title of her dissertation was the "Acceptance of Bread with Partial Replacement of Wheat Bread Flour by Potato Products in Selected Regions of the USSR and USA". She defended August 1, 1991.