7-2015

Preferences and Nutrient Composition: The Impact of Flour Types on Battered Fried Food

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Preferences and Nutrient Composition: The Impact of Flour Types on Battered Fried Food

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Human Environmental Sciences

by

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Bachelor of Health Science / General Business, 2012

July 2015
University of Arkansas

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ABSTRACT

This study investigated the impact of different flour-batter types on protein rich food in regard to people's overall liking and sensory preferences (saltiness, flavor, texture, moisture, and color). In addition, all battered fried chicken, fish, shrimp, pork, and beef were analyzed for fat, calories, and protein content in the Central Analytical Laboratory at the University of Arkansas. Two hundred thirty-five participants completed the questionnaire containing five major sections. Respondents evaluated samples of battered fried chicken, fish, shrimp, pork, and beef using all-purpose flour (APF), rice-flour (RF), and potato flour (PF). Data was analyzed using binomial analysis and paired sample t-test to determine whether a significant difference existed among participants' preferences, likings, and sensory evaluations regarding three types of flour used to batter chicken, fish, shrimp, pork, and beef. The laboratory results showed that RF was less fat absorbent, higher in protein, and lower in caloric content compared to APF and PF. Sensory evaluation results showed no significant difference in participants' preference comparing RF with APF. Therefore, this study suggested RF was a healthier alternative to APF. The findings of this study may be beneficial to full service restaurants, fast food chains, and families for home cooking.

ACKNOWLEDGEMENTS

I would like to express my special appreciation and thanks to my chair and advisor Dr. Robert J. Harrington for his devoted support and intellectual guidance from start to finish. His help has been invaluable over the years and I feel incredibly privileged to have him as my supervisor.

To my committee, Dr. Godwin-Charles Ogbeide, Dr. Han-Seok Seo, Mr. Allen Powell, and Ms. Mechelle Bailey; I am extremely grateful for your assistance and suggestions throughout my project. Especially to my two mentors, Dr. Ogbeide and Mr. Powell, for their wisdom, encouragement, and for pushing me farther than I dreamed of.

To my family and friends, especially my mother and my three best friends Nancy, Lydia, and Nushin for helping me survive all the stress from this year and not letting me give up.

I would like to give special recognition to Dr. Kelly Way, Leann Potts, and Nancy Simkins for their tremendous support and help throughout my academic endeavors.

DEDICATION

I dedicate this thesis to my wonderful parents Ali Siahmakoun and Mahi Ordoie and to my six brothers Azad, Farzad, Aref, Siamak, Sasan, and Babak Siahmakoun.

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CHAPTER 1

INTRODUCTION

According to USDA (2013), Americans spent half of their money on food with the majority spent on food away from home. Food preparation of breaded, battered and fried foods have been shown to be the most popular types (Bezerra, Curoni, and Sichieri, 2012; Stastny, Keith, & Garden-Robinson, 2014).

Batters are used to increase the quality of fried food (Dogan et al. 2004). Texture, moisture, oil contents, porosity, color, taste, and nutrition are the basic quality factors of fried food (Dogan et al., 2004). According to Choe and Min (2007), the batter type, frying oil, moisture, and frying time of the food influences the amount of oil absorption throughout the food frying process. There are different types of batters. Some batters are like liquid dough, which are very popular for deep-fat frying of all different kind of proteins, vegetables, cheese, and seafood. Another type of batter, which is used mostly for pan frying proteins and vegetables, is a three-step batter (flour-egg-flour). The three-step (flour-egg-flour) is very beneficial because the first step, which is the flour, closes all the pores of the food item, then the egg-wash is added with all the spices, and finally another coat of flour. Closing the pores of the food item is important because the oil only can penetrate through the pores. Fiszman and Salvador (2003), states that the battering system is a complex system where certain frying characteristics need to be met before and after frying (Fiszman & Salvador, 2003).

Frying food is a very convenient method of cooking and, in today's world, is one of the most important aspects of the operations in regard to the catering business and the food processing industry (Fillion & Henry, 1998; Block, Scribner, & DeSalvo, 2004).

Battered fried food items are popular; however, according to earlier studies indicate people are becoming more concerned about their diets, especially reducing fat and cholesterol from their daily dietary intakes while increasing vitamins and minerals (Fillion & Henry, 1998).

According to Block, Scribner, & DeSalvo (2004), there are essential genetic and environmental factors leading to obesity and causing an obesity epidemic around the world. Increased food consumption is one of these recent changes to this epidemic that includes bigger portions and cheaper, high-caloric foods (Block et al., 2004). In the last 20 years, the daily total calories from fast food consumption has increased from 3% to 12% making the fast food industry's growth an important environmental aspect in increased of food consumptions (Block, Scribner, & DeSalvo, 2004). According to Block et al. (2004), there is a relationship between fast food consumption and body mass index (BMI) plus weight gain.

What people eat plays a big role in regard to prevention of chronic diseases and maintaining a healthy weight (Story, Kaphingst, Robinson-O'Brien, & Glanz, 2007). Nutrition and eating patterns are key aspects of people's health (Story et al., 2007). High calorie dense foods, foods and drinks high in sugar content, along with bigger portions and relatively low prices are all causing American's health concerns (Story et al., 2007). Researchers suggest that eating behaviors are very complex with multiple aspects causing, and controlling the choice of food (Story et al., 2007). Story et al. suggests that individuals, especially children, need to be in a supportive environment both at home and outside the home in order to make better food choices. There are few studies available about environmental and policy influences on nutrition and eating behaviors, since this is a new, growing science (Story et al., 2007).

The main concern of many earlier investigations was both the explanation for and people's understanding of healthy and unhealthy eating (Povey, Conner, Sparks, James, &

Shepherd, 1998). Povey et al. stated that people of different age groups, gender, and educational levels had different perceptions of dietary intakes. As a result, Povey et al. (1998) suggested that the focus should be on physical and psychological constrains to healthy eating instead of just increasing public knowledge. However, there are numerous arguments suggesting this is not always the case. Assumptions are made regarding a direct relationship between information awareness and healthy or unhealthy food decisions. Many factors can influence healthy perceptions such as: gender, income, food preferences of men and children, differing nutritional advice by dietary experts, public beliefs, and differences among professional knowledge (Povey et al., 1998). An overall sense of well-being is also considered an aspect of healthy eating, which is the foundation of disease prevention for heart disease, diabetes, high blood pressure, stroke, cancer, dental caries, and asthma (Shepherd, Harden, Brunton, Oliver, & Oakley, 2006). Shepherd et al. (2006), reports that young people associate healthy eating with parents/adults, and home, while unhealthy food is related to pleasure, friendship, and the social environment. However, among young people, fast food is the dominant food choice based on taste (Shepherd et al., 2006).

Therefore, healthy alternatives are needed to address all the health concerns. When comparing rice flour to wheat flour in battered fried food, Shih and Daigle (1999) show that rice flour absorbs less oil than wheat flour but the thickening effect is not as good as wheat flour (Dogan et al., 2004). The sensory evaluation (saltiness, flavor, texture, moisture, and color) of rice flour versus all-purpose flour has not yet been fully tested, and with new trends in menu labeling, and more nutritional information on menus, it is possible that rice flour could be promoted as a healthier, lower-calorie alternative to all-purpose flour, if consumers like the taste.

Purpose of Study

The purpose of this study was to determine preferences and nutrient compositions of flour types in battered fried food. One key objective of this study was to investigate the potential of using rice or potato flour as a healthier alternative to all-purpose flour in fried foods as both were less fat absorbent. Toward this end, the analysis was done through comparison of different battering flours (all-purpose flour, rice flour, and potato flour), sensory evaluations (saltiness, flavor, texture, moisture, and color), and quality perceptions of the respondents. Additionally, samples were analyzed in an analytical laboratory for fat content, protein, and calorie percentages. The study was important in its implications for healthier eating habits in order to prevent chronic diseases such as diabetes and heart diseases. The findings may be beneficial to full service restaurants, fast food chains, food processing, and families home cooking.

Problem Statement

As earlier studies indicated, an understanding of social and behavioral aspects of food and nutrition was important (Bisogni, Jastran, Seligson, & Thompson, 2012). Researchers believed that public opinion about food, nutrition, and health was very different in comparison to the food and nutritional views of experts (Bisogni et al., 2012). Therefore, the initial goal of this study was to investigate an alternative fried food preparation evaluation by comparing rice, wheat, and potato flour in a battering system used to pan fry different protein rich food (beef, pork, chicken, fish, and shrimp). Specifically, the benefits of using rice or potato flour instead of wheat could help restaurants and families to make better food choices in regard to hypoallergenic and gluten free choices to help people with celiac disease and gluten sensitivity.

Objectives

The following objectives were developed in order to achieve the purpose of this study as previously mentioned:

1. To examine liking levels, quality levels, and sensory assessments of food qualities (saltiness, flavor, texture, moisture, and color) of fried food using alternatives to wheat flours.
2. To determine the impact of different protein types on battered fried food preferences and sensory qualities.
3. To provide information about nutritional value through comparison of five different protein rich fried foods (i.e. chicken, fish, shrimp, pork, and beef) with different flours (all-purpose flour, rice flour, and potato flour) used in the battering process.
4. To introduce the three-step dry-wet-dry battering system as an alternative to liquid dough batters.
5. To determine the acceptability of various flour types in battered, fried foods and the implications for healthy food choices.

Research Questions

Based on the objectives stated above, this study sought to answer the following research questions:

1. Do participants have preferences for fried food based on flour type?
2. Does this preference vary by protein type?
3. Is there a difference in quality perception among flour types? Do quality perceptions also vary by protein type?
4. What are the liking differences by flour and protein types?

5. Is there a difference in "just right" sensory characteristics among flour types? And among protein types?
6. Are there any differences in calorie, fat, and protein content among protein rich food battered in all-purpose, rice, and potato flours?

Definition of terms

Porosity – The quality of being porous, liquids go right through things that have porosity

Rheological Properties – Flow of the matter

Viscosity – a measure of its resistance to gradual deformation by shear stress

Pragmatic – dealing with things sensibly and realistically in a way that is based on practical rather than theoretical consideration. (Food Safety News, 2014)

Battered Fried Food – for this study, pan fried protein rich food battered in three-step (flour-egg-flour) system using all-purpose flour, rice flour, and potato flour

CHAPTER 2

LITERATURE REVIEW

In order to formulate the research questions, prior studies were reviewed as they related to chicken, fish, shrimp, pork, and beef battered with different flours and their nutritional effect in regard to fat, calories, and proteins. The following sections review prior research, identify the research gap, and explain the reasoning for the methodology used in this study in the following order: 1) fried food and battering system, 2) healthy food choices, 3) the cultural impact of food choices, and 4) American home cooking.

I. Fried Food and Battering System

According to Mellema (2003), the demand for reducing the fat content of fried food had increased significantly. However, also according to Mellema (2003), deep-fried foods were very popular because they were very tasty, and the complimenting dry-crispy outside versus tender-moist inside texture made them very appealing and desirable. As fried foods contained a significant amount of fat, up to one-third of the total weight of the item, there was a high level of satiety. In previous research, saturated animal fat was connected to obesity and coronary heart diseases, which increased the desirability of reducing the consumption of food with such high fat content. In the process of deep-fat frying, the more water that would evaporate, the more fat uptake would occur; this happened logically because oil penetration occurred only where the water evaporated, and only at a very high temperatures (Mellema, 2003). To modify the fat uptake process, which mostly happened after removing food from frying fat, important aspects were involved: proper frying temperature, frying time, and shaking and draining of the frying food item (Mellema, 2003). Mellema (2003) also noted that obviously the shape of the food would affect the total fat uptake since the fat uptake was a function of the surface; thereby,

showing the importance of the battering characteristics. There were several techniques that affected the reduction of fat uptake in fried food, for example, the moisture content, the evenly cut surface of the food, and pre-drying of food products (Mellema, 2003).

Batter was a complex, sophisticated system and defined as a liquid dough that basically consisted of water and flour, into which a food product was dipped before frying (Fiszman & Salvador, 2003). Battering of food products enhanced the flavor, texture, and appearance of the food; these factors acted as a barrier against moisture loss by protecting the natural juices of the food products from reheating, freezing, or frying (Fiszman & Salvador, 2003). These factors affected the rheological properties of batters including the composition and proportion of the ingredients, the solid water relationship, and temperature, all of which were dependent on other factors such as shear rate, duration of shearing, and previous thermal and shear histories (Fiszman & Salvador, 2003). If a batter was too thick, then it could cause a not perfectly cooked final product as well as a lack of crispness and a lumpy appearance. Rice starch in comparison to wheat starch had a different size and shape of the granules; as a result, rice and wheat batters have different gelatinization properties, water absorption rates, and swelling capacities (Fiszman & Salvador, 2003). Substitution of rice flour for wheat flour could change the rheological properties of the batter (Fiszman & Salvador, 2003).

Wheat flour was an important component in the battering system and was used mostly for deep-fat frying (Lee et al., 2012). Starch in the wheat flour contributed to the porous nature of the batter and the high level of absorbed oil (Lee et al., 2012). When rice flour was added to a batter, it formed a gel when it came in contact with hot oil, which decreased the oil absorption, hindered the moisture loss, and reduced the oil entry (Lee et al., 2012). Using rice flour as a substitution to wheat flour in a batter decreased the oil absorption properties while frying, but

adding rice flour to an all-purpose flour batter as a thickening component may reduce the thickening property (Lee et al., 2012).

Rice and rice products had become more recognizable because they were highly nutritious plant source foods beneficial to human health (National Committee of the American Heart Association, 1998). According to Shih and Daigle (1999), rice and rice components were highly hypoallergenic (very low tendency to cause allergic reaction) and also very easy to digest; therefore, could be used in baby foods. In addition, rice flour was a desirable alternative for individuals with celiac disease because it was gluten free, contained low levels of sodium, and had easily digested carbohydrates (Sanchez, Osella, & De la Torre, 2002).

The oil uptake in fried foods became a concern because it could lead to potential health problems including obesity; hence, the government and consumer groups increased the pressure to decrease or control the oil and fat in foods (Shih & Daigle, 1999). According to Shih and Daigle (1999), the viscosity of a batter was one of the most important aspects of oil uptake of fried food batters during frying. When comparing frying rice flour batter and all-purpose flour batter, the findings showed the oil retention of the fried batter ranged from 27.6% for the pure rice flour to 49.3% for the pure wheat flour batter, which meant that rice flour had a better oil resistance; but, at the same time, the viscosity in the rice flour batter was lower and became more brittle and harder to chew than wheat flour batter (Shih & Daigle, 1999). Depending on frying conditions such as time, temperature, and batter material, the batter's viscosity and oil uptake also varied (Shih & Daigle, 1999). Wheat flour, according to Shih and Daigle (1999), had more sympathy for oil absorption because of the hydrophobic wheat gluten that made the all-purpose flour more porous compared to rice flour; and, therefore, more viscosity accompanied more oil

uptake. Shih and Daigle (1999) summarized that the batters from long-grain rice flour absorbed less oil while frying than all-purpose flour batters.

II. Healthy Food Choices

In the United States, obesity and the tendency toward being overweight had increased dramatically among children in the last 30 years (Taveras, Berkey, Rifas-Shiman, Ludwig, Rockett, Field, Colditz, & Gillman, 2005). Whereas, the number of overweight and obese people had doubled from 1998 to 2008 worldwide (Bos, Van der Lans, Van Rijnsoever, & Van Trijp, 2013). The shift in meals being prepared and consumed away from home may be a significant reason for the cause of being overweight and obese (Taveras et al., 2005). Consumption of meals prepared outside the home could potentially result in poorer food quality, doubling the intake of high energy density meals at restaurants and fast food establishments (Taveras, et al., 2005). Bos et al., also suggested excessive calorie intake and lack of physical activity as the cause of the weight increase.

Bos et al. (2013) claimed that there was a wide range of interventions from public health policies to taxation of high calorie foods that would decrease the levels of obesity and, therefore, investigated (through interviews) two main subjects in relation to the dominance of obesity (a) the awareness of the problem and (b) responsibility of food choices. Participants also stated that parents were responsible for the healthy food choices of their children and parents were the intervention source for the children's healthy food choices both educationally as well as in marketing (Bos et al., 2013). Another suggested cause of obesity was making choices between healthy and unhealthy foods (Bos et al., 2013).

Sobal and Bisogni (2009) described making food decisions as a process that was compound, recurrent, and dimensional with constant changes, directed by people's food

behaviors. The authors identified many theories relevant to the food decision-making process including social behavior, social facts, and social definition perspectives (Sobal & Bisogni, 2009). The consumption of food was a necessity in regard to survival and body health; thus, it served as a worldwide, universal activity that required sufficient food decision-making competencies (Sobal & Bisogni, 2009). Food decision-making was usually repetitive and random, but at the same time, it could be remarkable and figurative (Sobal & Bisogni, 2009).

Sobal and Bisogni (2009) indicated that people obviously were involved in several eating and drinking incidents every day that included questions about: whether, what, where, when, with whom, how, how long, and how much. According to their estimate, people usually made 220 decisions about food every day (Sobal & Bisogni, 2009). As Sobal & Bisogni (2009) clearly pointed out, "food choice decisions are situational, dynamic, and complex". Food decisions were situational because they involved other aspects of a situation that included food behaviors such as place, time, etc. "Dynamic" meant that decisions changed over time; decisions people make today about food and eating were totally different than those of previous generations. Food decisions fell under the classification of "complex" simply because there were many different considerations to be made between food options, health, taste, and so on (Sobal & Bisogni, 2009)

Among all the models created by the experts, the deduction model provided new perspectives in regard to food decision-making. The deduction model was developed based on the experts' experiences and observations, with model especially tailored for food decision-making (Sobal & Bisogni, 2009). Food choice decisions could be influenced by particular life course changes and individuals might change their particular food decisions due to events and cultural norms over their life course (Sobal & Bisogni, 2009). In addition, people of specific ethnic groups might follow particular food choice patterns due to culture, religion, or areas in

which they lived. Food characteristics, contexts, and or personal experiences were the foundations of simplifying food decisions based on food classifications and circumstances (Sobal and Bisogni, 2009).

According to Bos et al. (2013), the accessibility and availability of low calorie food products was another issue pointed out by participants in their interviews. In many cases, unhealthy food choices were made due to the expense of healthy food options. It would be helpful if legal interventions and marketing could create lower prices for low calorie food products. The physical accessibility was also an issue regarding the supply and accessibility of low calorie food products (Bos et al., 2013). At the same time, not all the low calorie food choices were healthier and better because they possibly contained unhealthy fat and sugar (i.e., light soft drinks or less fat food products) (Bos et al., 2013). Identification of low calorie choices was another issue mentioned by participants in this study, simply because the nutritional facts on the food packages were not clear enough for everybody to understand (i.e., E-numbers as chemical additives on ingredient lists) (Bos et al., 2013). In that regard, participants liked the alternative use of the "traffic light" color system showing the nutritional value of the food product because it was easy and simple to use (Bos et al., 2013). Bos et al. (2013) concluded that most of the participants stated that children should be taught not only about foods, where they originate, and healthy eating, but also about respect for freedom of choice without any restrictions.

Additional studies indicated that people's healthy food choice purchases were based on taste, and the assumption that "healthy food will not taste good"; therefore, these perceptions tended to influence their purchasing of healthy food items even when the healthy food items were cheaper (Horgen & Brownell, 2002).

Different models showed the relationship between healthy behavior and self-control, but there was the argument among researchers as to whether self-control was necessary for making healthy food decisions (Salmon, Fennis, De Ridder, Adriannse, & De Vet, 2014; Hofmann, Friese, &Wiers, 2008; Schwarzer, 2008). Salmon et al. (2014) argued that people's food decisions were made mindlessly; therefore, self-control would not work for making healthy food choices. Salmon et al.'s (2014) approach was to provide customers in low self-control situations with an instinctive urge for healthier food choices, rather than fight their urges. Salmon et al. (2014) also argued that low self-control did not necessarily denote making unhealthy food decisions; rather, external cues were more influential in making these decisions, despite a person's low or high self-control. Without any external heuristic cues in association with healthy foods, no healthy food choice could prevail (Salmon et al., 2014).

III. Cultural Impact of Food Choices

According to a study done by Richard Shephard (1999), there were many factors affecting food choices including social and cultural factors. Shephard (1999) stated that food choice was a complex human behavior influenced by numerous connecting factors, especially in cultures that designated choice categories and food behaviors. Sensory characteristics (flavor, texture, and appearance) of a particular food might or might not have an effect on the consumption of a food, more so than the preference of individual likes and dislikes of the characteristics of that food (Shephard, 1999). Research indicated that not only different personalities affected the food choice but other factors such as social, cultural, religious, or demographic aspects might influence food choices (Murcott, 1989; Shepherd, 1989). Research done by de Castro and de Castro (1989) indicated that the environment where the meal was eaten had an effect on food choices, along with how many people ate together being in direct

correlation with the relationship to the amount of food consumed (Shephard, 1999).With so many potential factors influencing food choices, it was hard to make effective dietary changes despite the feeling that there was a need for a change (Shephard, 1999).

IV. American Home Cooking

Young adults, seniors, women, and Hispanics were eating less produce, and the number of people who had increased weekly fruit and vegetable consumption decreased (Gustafson, 2012). According to Harry Balzer, the vice president of NPD Group (a consumer research firm), frozen and pre-prepared meals had gotten very popular and people wanted to spend the least time possible preparing meals; thereby, impacting the present eating behavior (Gustafson, 2012). The U.S. Department of Agriculture's Economic Research Service (ERS) conducted a survey about how much time Americans spent on food, and the result was not surprising: "Americans skip breakfast, like to eat quickly, take shorter lunch breaks, and don't spend much time on preparing foods." The second result of this study was that, especially among the younger generation, the secondary eating pattern became very popular. The secondary eating pattern was described as a tendency for eating and drinking while doing other things. The result of this pattern was an increase of body mass index (BMI) (Gustafson, 2012).

According to the Gallup Health Ways study by Timi Gustafson RD, the average American family ate mostly at home but did not prepare meals from scratch. Based on nutritional food quality, recent eating habits had not improved and, in many cases, had gotten worse in some ways such as lower produce consumption (Gustafson, 2012).

Harris Interactive conducted an on-line poll between May 10 and 17, 2010 that consisted of 2,503 adults (aged 18 or over) (Corso, 2010). According to this poll, 79% enjoyed cooking, 30% loved to cook, 49% enjoyed cooking if they had time, 14% did not enjoy cooking, and 7%

did not cook at all (Corso, 2010). The findings also indicated that the frequency of preparing meals at home was a generational matter; for example, 52% of mature adults (those 65 and older) cooked at home five or more times per week, but younger generations prepared meals much less frequently (Corso, 2010). In this poll, people explained how they cook; for instance, 81% among those who cooked at home said they mostly cooked familiar foods, 75% reported they very often used pre-prepped or frozen ingredients, and most reported they used toaster ovens or microwave to cut down the cooking and cleaning time (Corso, 2010).

Summary

This chapter reviewed the literature on fried food and battering systems, healthy food choices, the cultural impact of food choices, and American home cooking. In summary, the literature established a number of contributors to the obesity problems; and, that rice flour or other preparation methods in battered fried foods provided more potential as healthier ingredients substitutes for wheat flour. While studies showed a relationship between convenience foods and food that was consumed away from the home to weight control and obesity, studies also indicated individuals enjoyed cooking at home if time and knowledge constraints could be reduced.

A review of previous studies showed that people liked battered fried food, and even though consumers were more aware of body health, the tendency to gravitate toward battered fried food was still present. Considering the rice flour characteristics as less fat absorbent and the gluten-free nature of other alternatives (i.e. potato flour), additional studies may be needed to determine if consumers have preferences for products prepared with differing flours in battered chicken, fish, shrimp, pork, and beef, and if these different preparations would impact sensory qualities such as saltiness, flavor, texture, moisture, and color of battered fried chicken, fish,

shrimp, pork, and beef. Further, nutritional analysis using study samples (battered fried chicken, fish, shrimp, pork, and beef) could provide valuable information for differences in calories, fat, and protein based on flour type (all-purpose, rice, and potato flour) and protein type (chicken, fish, shrimp, and beef).

With the new trend of adding nutrition information to restaurant menus, especially in full service restaurants, this study may be a contribution toward educating consumers in regard to healthy food choices, as well as restaurants and food processors toward promoting local rice and potato products.

CHAPTER 3

METHODOLOGY

Introduction

Quantitative analysis was used in this study for comparing rice flour and potato flour with all-purpose flour. This chapter focuses on research design, the food preparation process, pilot and primary tests, instrumentation, and data analysis.

Research Design

The research design consisted of a survey assessing the participants' evaluation of each battered fried product for liking level, quality level, preferences, and sensory characteristics based on saltiness, flavor, texture, moisture, and color. This assessment compared three types of flours and five types of protein rich foods. The survey development included a review of the literature and feedback from four professors with a combined industry experience of 45 years, who specialized in food and beverage management. Based on this feedback, the initial survey was used in a pilot test using junior and senior level students enrolled in a food and beverage management course at the University of Arkansas (HOSP 3601 Menu Layout & Food Preparation). In this pilot process, students evaluated all of the protein rich foods and flour preparations for liking, quality, and sensory characteristics of saltiness, flavor, texture, moisture, and color. Based on this pilot, the survey instrument received minor revisions prior to use in the primary test in this study.

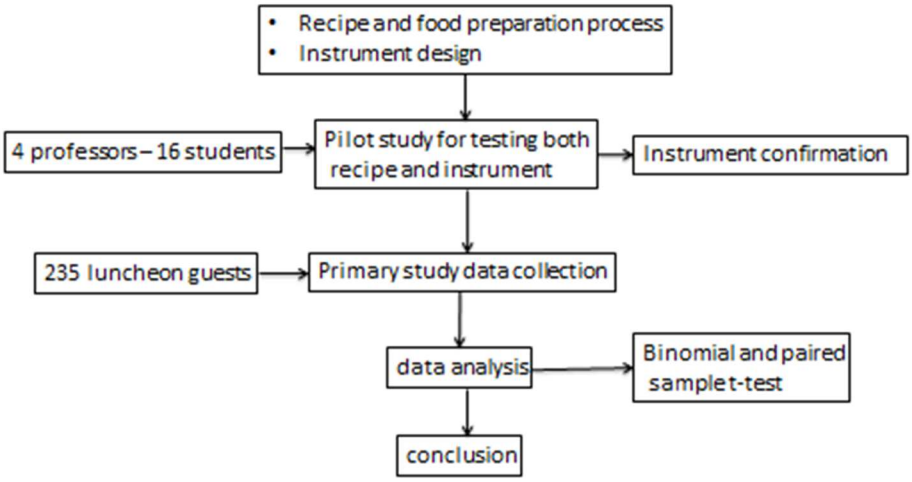
The primary test was then given to luncheon guests of a simulated student-managed restaurant on the campus of a mid-south, land-grant university on every Monday and Wednesday for five weeks, starting March 9, 2014 (See Appendix A). The class and the guests were

informed that participation was voluntary and all information gathered as a result of the survey was confidential. No names or identifying information of any kind was obtained.

Institutional Review Board approval involving human subjects, (protocol number 14-02-544) was obtained before any data collection began in March 2014. (See Appendix B) and participants signed the consent form prior to participation (See Appendix C).

Figure 3.1 provides an overview of study steps.

Figure 3.1 The Stages of the Study



Food Preparation Process

A standardized recipe was used throughout this study, meaning that a recipe (see Figure 3.2) had been tested, adapted, and retested several times to prepare the battered fried food in the same manner in order to produce the same result each time. The standardized recipe ensured that all battered, pan-fried protein rich food would be consistent in quality and nutritional values each time they were prepared and tasted for this study. Prior to cooking, protein rich foods were

trimmed of fat, washed, and pat-dried. A mallet was used to tenderize and flatten the surface of chicken (breast), fish (catfish), pork (pork chop), and beef (cubed steak). After this process, chicken, fish, pork, and beef were cut into strips (2 x 1 inches) and all, including shrimp, were battered in a three-step system (flour-egg-flour). A 16-inch, shallow fry pan was heated on the stove top and consistent amount of canola oil was used to cover the bottom of the pan to a 1/4-inch depth (pan frying is an oil-based cooking technique that uses a layer of heated oil to coat the pan and fry protein one side at a time). First, battered protein rich foods were immersed in the oil on one side until golden brown, and then flipped to the other until golden brown. Fried protein rich foods were ready when both sides had taken on a consistent golden brown color. After the battered fried protein rich foods were fried and taken out of the pan, they were put on parchment paper to drain the excessive fat. On varying days, one protein rich food (chicken, fish, shrimp, pork, and beef) would be chosen to be pan fried. All choices were consistently battered with all-purpose flour batter and fried separately in one pan. For comparison, that same protein choice for that day was also battered in either rice flour or potato flour in a separate pan using the same process. As prescribed in the survey, a tooth pick was put in protein rich foods battered either with rice or potato flour to designate one sample from another without specifying the flour used (i.e. APF vs. RF or PF) to participants.

Figure 3.2

Standardized Battering Recipe

Battering Recipe:

This recipe was used throughout the study to batter and pan fry all the protein rich foods.

Ingredients:

8 eggs
1 Tb paprika
1 tsp each: garlic, chili pepper, salt, black pepper, and turmeric (add to beaten eggs)
1 tsp each: baking soda, paprika, and garlic powder (add to flour)
3 cups of flour
1 Tb paprika
Proteins:
Chicken, Fish, Shrimp, Pork, and Beef
Flours:
All-purpose flour (ConAgra Mills, enriched and bleached, 25 lb. bag)
Rice Flour (Bob's Red Mill, white rice flour, 24 oz. bag, gluten free)
Potato Flour (Bob's Red Mill, 24 oz. bag, gluten free)

Directions:

1. Trim all the excess fat, wash, and pat-dry protein
2. Cut the protein in 1 x 2 inch strips, except for shrimp
3. Rub fish and shrimp with fresh lime before battering
4. Beat eggs in a mixing bowl and then mix in the spices
5. Mix flour with baking soda, paprika, and garlic powder
6. Batter the proteins using a three-step system (flour-eggs-flour)*
7. Fry the protein in a 16-inch, shallow frying pan using canola oil (1/4-inch to cover bottom of the pan
8. Proteins are drained on parchment paper after frying

*Flour-egg-flour, three step battering system, protein rich foods (chicken, fish, shrimp, pork, and beef) were coated first with flour to close the pores, and then dipped into spiced beaten eggs, then into flour again

Pilot Test

The participants of the pilot test were 16 students of the HOSP 3601 (Menu Layout and Food Preparation) laboratory class. The survey started with demographic questions: gender, age, ethnicity/race, education level, and home town so that comparisons could be made between like group participants (Povey, Conner, Sparks, James, & Shepherd, 1998). After the demographic questions, the self-assessment sections began with questions about health status, smell and taste functions, the frequency of fried food consumption, and allergies in general (Harrington & Hammond, 2010). In the pilot test section, there were 16 participants (n=8 females, n=8 males) who were between the ages of 18 and 24, with no allergies, all in a very good health with good, functional taste and smell. In the evaluation section of the pilot-test, participants were asked to what extent they would evaluate the items with the responses measured on a five-point Likert scale ranging from "not at all" to "too much" (Povey et al,. 1998). Five of the participants (31.25%) consumed fried food once a month, four (25%) only two to three times a week, and only one (6%) person ate fried food four or more times a week.

In the pilot test, students tried five pan fried protein rich foods (beef, pork, chicken, fish, and shrimp) with different flour batters (all-purpose flour, rice flour) at one setting to compare the saltiness, flavor, texture, moisture, color, liking, and overall quality while eating. To measure the saltiness, flavor, texture, moisture and color, participants were asked a five-point Likert scale question with the designations of: not at all, not quite enough, just right, a little too much, and too much. As another example, participants were asked about their taste level of like or dislike of the items with a five-point Likert scale ranking: dislike extremely, dislike moderately, neither dislike nor like, like moderately, like extremely. To measure the overall taste quality of the fried protein rich foods, students were asked to rate the quality with a five-point Likert scale: very

poor, poor, average, good, and excellent. At the end of each questionnaire, to compare the two protein rich foods using different flours in the battering system, they were asked which item they preferred the most, Item A or Item B (Item A was always the protein battered with the all-purpose flour; Item B alternated between rice or potato flour batter).The only difference between the pilot test and primary test was that in the pilot test the students tasted all five--chicken, fish, shrimp, pork, and beef--in one setting.

Primary Study

Convenience sampling was used for choosing participants of this study. The sample included 235 respondents who were chosen by using the luncheon guests of a simulated student-managed restaurant. These luncheons were provided by students from the Food Preparation and Menu Layout class and held on Mondays and Wednesdays during the last five weeks of the Spring Semester 2014. During the five weeks of luncheons, the participants tasted two different protein rich foods (chicken, fish, shrimp, pork, and beef) before their meals and then answered the survey questions.

To ensure the representativeness of this study's sample, the researcher compared the sample of this study with the population of the State of Arkansas and City of Fayetteville. According to the United States Census Bureau, the State of Arkansas' population consisted of 50.90% males, and 49.10% females as compared to Fayetteville, Arkansas with 50.28% male, and 49.72% female. In this study, the sample consisted of 33.07% males, and 58.17% females.

The demographic characteristics of the respondents were described for male and female students, faculty/staff, and guests from University of Arkansas. There were 83 (33.07%) male respondents and 146 (58.17%) female respondents. (Table 3.1)

In terms of the Ethnicity/Race classification, the majority of survey respondents, 199 (84.68%), were White/Caucasian, with the next highest number, 20 (8.51%) as other, meaning respondents considered themselves to fall into the "other" category, 8 (3.40%) were American Indian, 5 (2.13%) were Asian/Pacific Islander, and the smallest category, Black/African American, made up of 3 (1.28%) respondents. (Table 3.1)

Of those that completed the education section, the majority of participants had completed a master's degree (74 or 29.48%), followed by those who held a doctorate ranking (64 or 25.50%), those with bachelor's degree (62 or 24.70%), and respondents with a high school diploma (48 or 19.12%). (Table 3.1)

Table 3.1

Demographics of Participants

	Total w/out Pilot Test	Total w/out Pilot Test (%)
Gender	**235**	
Male	75	31.91%
Female	138	58.72%
Unmarked	22	9.36%
Age Range		
18-24	57	24.26%
25-34	45	19.15%
35-44	10	4.26%
45-64	98	41.70%
65 or Older	27	11.49%
Unmarked	1	0.43%
Ethnicity/Race		
American Indian	8	3.40%
Asian/Pacific Islander	5	2.13%
Black/African American	3	1.28%
White/Caucasian	199	84.68%
Other	20	8.51%
Education		
High School	38	16.17%
Bachelor's Degree	58	24.68%
Master's Degree	72	30.64%
Doctorate	64	27.23%
Unmarked	3	1.28%

1- For age range, a 5-point scale was used: 1 = 18-24, 2 = 25-35, 3 = 35-44, 4 = 45-64, and 5 = 65 or older.

2- For Ethnicity/Race, a 5-point scale was used: 1 = American Indian, 2 = Asian or Pacific Islander, 3 = Black/African American, 4 = White/Caucasian, 5 = other.

3- For Education level a 4-point scale was used: 1 = high school, 2 = bachelor's degree, 3 = master's degree, 4 = doctorate.

Instrumentation

The instrument design consisted of a descriptive, in-person survey. A self-administered questionnaire was developed for this study based on a three step process: (a) review of literature, (b) feedback from faculty experts in restaurant management and food science, and (c) feedback from a pilot study utilizing students enrolled in Menu Layout and Food Preparation Lab class. The students of the Menu Layout, and Food Preparation class were used as participants to test the content validity and clarity of the questionnaire (Appendix B). There were no changes needed in questionnaire for the primary test. In the primary test, the guests completed the survey comparing and evaluating one protein with two different breading flours. To prevent biased results, the participants in the primary test were not told the differences in the breading (flour type).

The final survey contained five major sections. The first section asked demographic information, which consisted of gender, age, ethnicity/race, degree level completed, and national origin. A five-point Likert scale was used for age, ranging from 18 to 65. All these factors (gender, age, ethnicity/race, and education level) determined the role of food consumption in regard to health, lifestyle, nutrition, and weight control (Glanz, Basil, Maibach, Goldberg, & Snyder, 1998). Five ethnic/racial groups were defined: American/Indian (n=8), Asian/Pacific Islander (n=6), Black/African American (n=3), White/Caucasian (n=212), and other (n=22). Education level was ascertained by the highest degree completed. This was classified into four categories: high school (n=48), bachelor's degree (n=62), master's degree (n=74), and doctorate (n=64).

In the second section, participants were asked about their health status, smell function, and taste function. For the first part of this self-assessment section, a five-point Likert scale was used gauging: very bad, bad, neither bad nor good, very good.

The third section asked participants about frequency of fried food consumption and allergies to food and drink. The frequency of fried food consumption question consisted of a five-point Likert scale of: never, once per month, once per week, 2-3 times per week, 4 or more times a week. The last part of this section was a yes or no question about allergies to food, and drink.

Section four consisted of the sensory evaluation of the two fried food items sampled each day, which were listed as Item A and Item B (with toothpick). The first part of this section asked the respondents the level of saltiness, flavor, texture, moisture, and color of each item using a five-point Likert scale from "not at all" to "too much".

Section five included two questions. The first part of this section asked how much the respondent liked or disliked the food item using a five-point Likert type scale from "dislike extremely" to "like extremely." The second question asked how the respondent would rate the overall quality of the food item with five response options ranging from "very poor" to "excellent."

The last item of the survey consisted of one question asking the respondent to select A or B (with toothpick) as the food item preferred overall.

Survey administration

The luncheon guests tried only one, fish, chicken, shrimp, pork, and beef each time. All five protein rich foods were battered and pan fried with the same standard recipe (Figure 3.1). Each guest tasted and compared two different flour types each time used on one chosen protein.

To measure the saltiness, flavor, texture, moisture and color, participants were asked a five-point Likert scale question with the designations of: not at all, not quite enough, just right, a little too much, and too much. As another example, participants were asked about their taste level of like or dislike of the items with a five-point Likert scale ranking: dislike extremely, dislike moderately, neither dislike nor like, like moderately, like extremely. To measure the overall taste quality of the tasted fried protein rich foods, students were asked to rate the quality with a five-point Likert scale: very poor, poor, average, good, excellent. At the end of each questionnaire, to compare the two protein rich foods using different flours in the battering system, they were asked which item they preferred the most, Item A or Item B (Item A, the protein battered with the all-purpose flour; Item B protein battered with either rice or potato flour for in comparison).

Data Analysis

Data analysis was performed using SPSS 20.0 for Windows (IBM SPSS Inc., Chicago, IL, U.S.A.). Descriptive statistics, Binomial tests, and paired sample t-tests were performed. The first part of data analysis involved a demographic profile of respondents. Demographic data from the questionnaires was tabulated using percentages and frequencies.

Results were tested using binomial analysis for Research Questions 1 and 2. Binomial analysis was an exact test that compared the observed distribution with the expected distribution in cases that consisted of two categories. Non-parametric binomial analysis was used to analyze data that did not meet the assumptions of parametric tests. In this case, the data for Research Questions 1 and 2 were categorical in nature (1=preferred sample, 0=non-preferred sample). Non-parametric tests were less powerful than parametric tests but allowed statistical tests that used both nominal and ordinal data types.

First, because the data in these research questions had two possible outcomes (either APF/RF or APF/PF), tests for participants' preferences were run using binomial tests. This test compared observed frequencies of two categories of a dichotomous variable to the frequencies that were expected under a binomial distribution with a specified probability parameter (Vogt, 1999).

Second, data was produced from Research Questions 1 and 2, asking whether participants had preferences for fried food based on flour type, and whether this preference varied by chicken, fish, shrimp, pork, and beef. To answer these questions, data was analyzed using binomial tests between different flour types. First, participant's preferences of chicken, fish, shrimp, pork, and beef battered with APF/RF were investigated. Second, preferences of chicken, fish, shrimp, pork, and beef battered with APF/PF were tested.

Third, data was produced from Research Question 3a and 3b, "is there a difference in quality perception among flour type? Do quality perceptions also vary by protein type?" A paired sample t-test was used to describe the difference in quality perception among flour type and protein type.

Fourth, tests to assess Research Question 4 asked if level of liking varied by flour or protein types. This test used paired sample t-tests.

Fifth, tests to assess Research Question 5 determined if differences existed in "just about right" measures by flour type or protein type for quality attributes of saltiness, moisture, color, texture, and flavor. Paired sample t-tests were used to assess any significant differences across flour or protein type.

Lastly, Research Question 6 asked if there was a difference in calories, proteins, and fat content of each sample (fried protein rich food battered with wheat, rice, and potato flour). To

determine if differences existed, food samples were sent to the Central Analytical Laboratory at the University of Arkansas where they were analyzed for protein, fat, and calories. Samples sent to the laboratory were first dried, ground, and then analyzed for calories, proteins, and fat content; the calculations were reported on an ‘as is’ basis.

CHAPTER 4

RESULTS

The findings from the tests for Research Questions 1 through 6 are provided in the following sections.

Research Questions 1 and 2: Do participants have preferences for fried food based on flour type? Does this preference vary by protein type?

In Research Question 1, the specified parameter was the participant's flour type preferences comparing APF to RF and APF to PF. In Research Question 2, participant's protein type preferences comparisons were tested (fish, chicken, shrimp, beef, and pork).

In order to further understand the participant's preferences for fried chicken, fish, shrimp, pork, and beef battered with different flour types (APF, RF, and PF) participants were asked to choose between Items A and B. This created a comparison between all-purpose flour (APF), rice flour (RF), and potato flour (PF) used in battering chicken, fish, shrimp, pork, and beef.

RF vs. APF results: In the first part, a comparison was made between All-purpose flour (APF) and rice flour (RF). 11 (68.75%) out of 16 participants preferred battered fried chicken made with APF, and 5 (31.25%) participants preferred battered fried chicken made with RF. From 19 respondents, 10 (52.63%) preferred battered fried fish made with APF, and 9 (47.36%) respondents preferred battered fried fish using RF; whereas, 22 participants tried the battered fried shrimp, 13 (59.9%) preferred battered fried shrimp made with APF, and 9 (40.90%) preferred battered fried shrimp made with RF.

From 22 participants, 14 (63.63%) preferred battered fried pork with APF, and 8 (36.36%) pork with RF. From 26 survey participants, 9 (34.61) preferred battered fried beef made with APF, and 7 (26.92%) preferred battered fried shrimp made with RF.

PF vs. APF results: In the second part, a comparison was made between All-purpose flour (APF) and potato flour (PF). From 15 participants, 7 (46.66%) preferred battered fried chicken with APF, and 8 (53.33%) preferred PF. From 26 participants, 12 (46.15%) preferred battered fried fish made with APF, and 14 (53.84%) preferred battered fried fish made with PF. From 27 participants, 11 (4.74%) preferred battered fried shrimp made with APF, and 16 (59.25%) preferred battered fried shrimp made with PF. From 26 participants, 10 (38.46%) participants preferred battered fried shrimp with APF, and 16 (61.53%) preferred battered fried shrimp made with PF.

The frequencies are shown in percentage form in Table 4.1 for all battered and fried chicken, fish, shrimp, pork, and beef; comparing first, APF with RF and second, APF with PF. Responses were coded as 1 for APF and 0 for RF, and in the second part, 1 for APF and 0 for PF.

Table 4.1 shows APF against RF, where there were three statistically significant differences in respondents' preferences when analyzed through binomial testing. First, battered fried chicken had a 0.002 in p-value. Second, battered fried shrimp was significant $p < 0.008$, and All-category had a $p < 0.000$ significant. These significant numbers showed that from a total 95 of the survey participants, 60% preferred the fried protein battered with the APF, and only 40% preferred all fried protein rich foods battered with the RF.

The second part of Research Question 1 showed that the following protein types: shrimp ($p < 0.04$), pork ($p < 0.014$), and beef ($p < 0.000$) with PF were preferred by the participants over the APF. From 115 survey participants, 60.90% preferred all fried protein rich foods battered with PF and 39.90% preferred all fried protein rich foods battered with APF, which was significant ($p < 0.000$).

Table 4.1

Flour Preferences by Protein Type

	Participants	APF	APF (%)	RF	RF (%)	P Value
Chicken	16	11	68.75%	5	31.25%	**.002**
Fish	19	10	52.63%	9	47.36%	.408
Shrimp	22	13	59.09%	9	40.90%	.066
Pork	22	14	63.63%	8	36.36%	**.008**
Beef	26	9	34.61%	7	26.92%	.111
All Proteins		57	60.00%	38	40.00%	**.000**

	Participants	APF	APF (%)	PF	PF (%)	P Value
Chicken	15	7	46.66%	8	53.33%	.396
Fish	26	12	46.15%	14	53.84%	.277
Shrimp	27	11	40.74%	16	59.25%	**.04**
Pork	26	10	38.46%	16	61.53%	.014
Beef	21	5	23.80%	16	76.19%	**.000**
All Proteins		45	39.10%	70	60.90%	**.000**

APF = All-purpose flour

RF = Rice flour

PF = Potato flour

1. Participants chose between Item A and Item B, comparing five different protein rich foods (chicken, fish, shrimp, pork, and beef) with three different flours (all-purpose flour, rice flour, and potato flour).

Research Questions 3a and 3b: Is there a difference in quality perception among flour type? Does this quality perception vary by protein type?

Results were tested using paired samples t-test for Research Question 3a. Paired sample t-test was used with only one group of people; also it was used to measure the same person's response to different questions. Paired sample t-test detected a difference between the means of two dependent variables. In this case the researcher was measuring the quality perception of the participants among flour types and the protein types using paired sample t-test.

Table 4.2a-shows the results of paired samples t-test comparing all flour types (APF, RF, and PF). Comparing APF to RF for saltiness, flavor, texture, moisture, and color only moisture showed a significant difference of 0.035 ($P<0.05$) and all the others showed no significant differences in all conditions. In the next step; when APF was compared with PF saltiness, flavor, moisture, and color showed significant differences.

Research Question 3b was concerning participants' preferences among protein types and used paired samples t-test as well. Battered fried chicken compared APF with RF and APF with and PF showed no significant differences, only a slightly significant difference in chicken battered with PF ($p = 0.06$). Table 4.2c represents battered fried fish compared with all three flours; APF with RF; only color showed some significant difference ($p = 0.25$) compared to all the other conditions. In the case of battered fish compared to APF with PF, moisture and color showed significant differences ($p = 0.019$, and $p = 0.04$). Table 4.2d indicated no significant differences about respondents' preferences regarding battered fried shrimp when comparing APF with RF. However, there was a significant difference when comparing APF with PF in moisture content ($p = 0.21$). Table 4.2e shows the indication of battered fried pork when comparing APF with RF, which had a significant difference in moisture ($p = 0.58$), and comparing APF with PF

had a significant difference in texture (p = 0.15), moisture (p = 0.22), color (p = 0.33), and slightly in flavor (p = 0.07). Table 4.2f represents battered beef; first comparing the APF with RF, and showed a marginal significant in saltiness (p = 0.20), and comparing APF with PF showed significant differences in saltiness (p = 0.08), flavor (p = 0.22), and slightly significant in moisture (p = 0.21). As a whole, these results provided indications of moisture preference first in PF, then APF, and finally, RF when comparing all these conditions.

In addition, the bigger the negative numbers, the lower the quality preference was for the respondents based on the five-point Likert scale used in the survey. For this scale, the choices were -2 = not at all, -1 = not quite enough, 0 = just right, 1 = a little too much, and 2 = too much.

Table 4.2a

Quality Perception-All Proteins

	APF	RF	APF	PF
Quality	3.52a	3.60a	3.58a	3.77b
Liking	0.80a	0.67a	0.61a	0.75a
Saltiness	-0.39a	-0.39a	-0.36a	-0.14b
Flavor	-0.38a	-0.38a	-0.48a	-0.30b
Texture	-0.17a	-0.15a	-0.09a	-0.15a
Moisture	-0.19a	-0.35b	-0.36a	-0.04b
Color	-0.07a	-0.13a	-0.15a	0.08b

P< 0.05

Table 4.2b

Quality Perception-Chicken

	APF	RF	APF	PF
Quality	2.93a	3.17a	3.85a	4.13a
Liking	0.80a	0.33a	0.57a	0.94a
Saltiness	-0.89a	-0.83a	-0.56a	-0.38a
Flavor	-0.61a	-0.44a	-0.50a	-0.50a
Texture	-0.39a	-0.44a	0.25a	-0.19a
Moisture	-0.67a	-0.94a	-0.31a	-0.19a
Color	-0.11a	-0.28a	-0.31a	-0.06b

Table 4.2c

Quality Perception-Fish

	APF	RF	APF	PF
Quality	3.67a	3.83a	3.63a	3.92a
Liking	0.65a	0.96a	0.71a	0.88a
Saltiness	-0.78a	-0.54a	-0.27a	-0.07a
Flavor	-0.35a	-0.29a	-0.48a	-0.33a
Texture	-0.04a	-0.08a	-0.07a	-0.22a
Moisture	-0.04a	-0.14a	-0.15a	0.19b
Color	-0.04a	-0.25+	-0.31a	-0.04b

+ P< 0.10

Table 4.2d

Quality Perception-Shrimp

	APF	RF	APF	PF
Quality	4.06a	3.92a	3.88a	3.79a
Liking	1.26a	1.13a	1.08a	0.86a
Saltiness	-0.08a	-0.20a	-0.38a	-0.41a
Flavor	-0.32a	-0.48a	-0.28a	-0.36a
Texture	-0.20a	-0.12a	-0.14a	-0.21a
Moisture	-0.04a	0.00a	-0.07a	0.21b
Color	-0.04a	0.00a	-0.03a	0.00a

Table 4.2e

Quality Perception-Pork

	APF	RF	APF	PF
Quality	3.52a	3.48a	3.29a	3.37a
Liking	0.82a	0.42a	0.33a	0.37a
Saltiness	-0.25a	-0.17a	-0.15a	0.07a
Flavor	-0.42a	-0.33a	-0.41a	-0.07+
Texture	-0.17a	-0.04a	-0.37a	0.15b
Moisture	-0.04a	-0.58b	-0.74a	-0.22b
Color	-0.25a	-0.17a	-0.15a	0.33b

Table 4.2f

Quality Perception-Beef

	APF	RF	APF	PF
Quality	3.42a	3.60a	3.26a	3.63a
Liking	0.47a	0.50a	0.37a	0.71a
Saltiness	0.05a	-0.20+	-0.42a	0.08b
Flavor	-0.20a	-0.35a	-0.71a	-0.22b
Texture	-0.05a	-0.06a	-0.13a	-0.29a
Moisture	-0.15a	-0.11a	-0.54a	-0.21+
Color	0.10a	0.05a	0.04a	0.17a

Research Question 4: What are the liking differences by flour and protein type?

Results were tested using paired samples t-test analysis for Research Question 4 ~~four~~. Based on findings from the paired samples t-test analysis, in all categories (APF, RF, PF), there were no significant differences in like or dislike when comparing APF to RF. There was also no significant difference when comparing APF to RF. In the case of protein type, when comparing APF to RF in battered fried chicken showed no significant difference; comparing APF to PF in battered fried chicken, results showed a slightly significant difference ($p = 0.104$). With the battered fried fish, neither of the comparisons (APF/RF, APF/PF) showed any significant differences for like or dislike. In the case of battered fried shrimp, neither APF to RF, nor APF to PF showed any significant difference in the like or dislike conditions. Like or dislike differences in the case of both battered fried pork and battered fried beef, neither showed any significant differences when compared to all three different flour types.

Table 4.3 presents the respondent's preferences by protein differences in liking level and quality, comparing all five different types of protein rich food (chicken, fish, shrimp, pork, and beef). The scale used for the liking level was dislike extremely = -2, dislike moderately = -1, neither dislike nor like = 0, like moderately = 1, and like extremely = 2. These measurements indicated that the higher the numbers, the higher the level of respondents' liking. Chicken was

the first with the highest number belonging to PF = 0.94, followed by APF = 0.69, and finally, RF = 0.33, which indicated PF was the preferable flour used to batter the chicken. Fish, was the next with a rating of RF = 0.96, APF = 0.92, and PF = 0.88; this meant respondents preferred the battered fried fish with RF. With the shrimp, the liking level was higher in APF = 1.17. Pork liking level highest number was APF = 0.58 and the liking level with beef was PF = 0.71.

Table 4.3

Protein Differences, Liking Level, and Quality

		Saltiness	Flavor	Texture	Moisture	Color	Liking	Quality
Chicken								
	RF	-0.83	-0.44	-0.44	-0.94	-0.28	0.33	3.17
	PF	-0.38	-0.50	-0.19	-0.19	-0.06	**0.94**	4.13
	APF	-0.73	-0.56	-0.07	-0.49	-0.21	0.69	3.39
Fish								
	RF	-0.54	-0.29	-0.08	-0.14	-0.25	**0.96**	3.83
	PF	-0.07	-0.33	-0.22	0.19	-0.04	0.88	3.92
	APF	-0.31	-0.31	-0.15	0.03	-0.15	0.92	3.88
Shrimp								
	RF	-0.20	-0.48	-0.12	0.00	0.00	1.13	3.92
	PF	-0.41	-0.36	-0.21	0.21	0.00	0.86	3.79
	APF	-0.23	-0.30	-0.17	-0.06	-0.04	**1.17**	3.97
Pork								
	RF	-0.17	-0.33	-0.04	-0.58	-0.17	0.42	3.48
	PF	0.07	-0.07	0.15	-0.22	0.33	0.37	3.37
	APF	-0.20	-0.42	-0.27	-0.39	-0.20	**0.58**	3.41
Beef								
	RF	-0.20	-0.35	-0.06	-0.11	0.05	0.50	3.60
	PF	0.08	-0.22	-0.29	-0.21	0.17	**0.71**	3.63
	APF	-0.19	-0.46	-0.09	-0.35	0.07	0.42	3.34

1-For Saltiness, Flavor, Texture, Moisture, and Color, these items used a 5-point scale from -2 = not at all, -1 = not quite enough, 0 = just right, 1 = a little too much, and 2 = too much.

2- For Liking level, these items used a 5-point scale from -2 = dislike extremely, -1 = dislike moderately, 0 = neither dislike nor like, 1 = like moderately, and 2 = like extremely.

3-For Overall Quality, these items used a 5-point scale from 1 = very poor, 2 = poor, 3 = average, 4 = good, and 5 = excellent.

Research Question 5: Is there a difference in "just right" sensory characteristics among flour type? And among protein type?

The strength of the model was determined using paired sample t-test analysis conducted to estimate the differences in "just right" characteristics among chicken, fish, shrimp, pork, and beef and flour types (APF, RF, and PF). To better understand which combination of chicken, fish, shrimp, pork, and beef and flour type were the "just right" preferences of the respondents; data was analyzed regarding "just right" characteristics. In a 5-point Likert scale (-2 = not at all to 2 = too much), participants evaluated different types of flour based on saltiness, flavor, texture, moisture, and color. Participants selected between Item A (battered fried protein with APF) and Item B (battered fried protein with either RF or PF).

There was a statistically significant difference in the first part of comparisons shown in Table 4.4a, when comparing APF to RF in pair 4 (APFM/RFM) with $p < 0.03$, and a 95% confidence interval. In the comparison of APF to PF, there were several significant differences; as seen in pair 1, APFS/PFS with $p < 0.008$; in pair 2, APFF/PFF with $p < 0.019$; in pair 4: APFM/PFM with $p < 0.000$; in pair 5, APFM/PFM with $p < 0.000$; and in pair 7, OQAPF/OQAPF with $p < 0.038$.

The negative numbers showed that responses leaned more toward the "not quite enough", or "not at all" in regard to saltiness, flavor, texture, moisture, color. There was a significant difference ($p < 0.031$) in moisture condition when comparing APF to RF and saltiness ($p < 0.008$), flavor ($p < 0.019$), moisture ($p < 0.000$), color ($p < 0.000$), and overall quality ($p < 0.038$) conditions when comparing APF to PF.

Table 4.4a

All Proteins

		APF /RF					APF /PF			
		M	**n**	**S.D.**	**P**		**M**	**n**	**S.D.**	**P**
Pair: 1										
	APFS	-0.37	110	0.648	1.000	**APFS**	-0.34	122	0.688	**0.008**
	RFS	-0.373	110	0.6333		**PFS**	-0.131	122	0.6797	
Pair: 2										
	APFF	-0.37	110	0.556	0.902	**APFF**	-0.45	121	0.632	**0.019**
	RFF	-0.382	110	0.6055		**PFF**	-0.281	121	0.632	
Pair: 3										
	APFT	-0.18	108	0.721	0.602	**APFT**	-19	123	0.705	0.555
	RFT	-0.139	108	0.7908		**PFT**	-0.146	123	0.6098	
Pair: 4										
	APFM	-0.17	107	0.666	**0.031**	**APFM**	-0.36	123	0.629	**0.000**
	RFM	-0.336	107	0.7261		**PFM**	-0.024	123	0.6461	
Pair: 5										
	APFC	-0.07	109	0.424	0.306	**APFC**	-0.14	121	0.537	**0.000**
	RFC	-0.128	109	0.4534		**PFC**	0.091	121	0.4655	
Pair: 6										
	L. or Dl.	0.80	95	0.918	0.243	**L. or Dl.**	0.64	107	0.829	0.311
	L. or Dl.	0.663	95	0.9522		**L. or Dl.**	0.738	107	0.8831	
Pair: 7										
	OQAPF	3.54	93	1.128	0.621	**OQAPF**	3.57	106	0.819	**0.038**
	OQRF	3.591	93	0.8627		**OQPF**	3.743	106	0.8089	

(**Table 4.4a Cont.)**

APFS = All-purpose flour saltiness
APFF = All-purpose flour flavor
APFT = All-purpose flour texture
APFM = All-purpose flour moisture
APFC = All-purpose flour color
L = Like
DL = Dislike
PFS = Potato flour saltiness
PET = Potato flour texture
PFC = Potato flour color
RFS = Rice flour saltiness
RFF = Rice flour flavor
RET = Rice flour texture
RFM = Rice flour moisture
RFC = Rice flour color
OQAPF = Overall quality all-purpose flour
OQRF = Overall quality all-purpose flour
PFF = Potato flour flavor
PFM = Potato flour Moisture
OQPF = Overall quality potato flour

Table 4.4b shows the analysis results comparing chicken APF to RF and APF to PF, using paired sample t-test. Data on the left side of the table shows battered fried chicken comparing APF to RF, with no significant difference. Data on the right side of the table compares battered fried chicken APF to PF, with only one significant difference in the condition of color ($p< 0.041$).

Table 4.4b
Chicken

	APF/RF				APF/PF				
		M	**n**	**S.D.**	**P**		**M**	**n**	**S.D.**	**P**
Pair:1										
	CAPFS	-0.89	18	0.583	0.749	**CAPFS**	-0.56	16	0.512	0.333
	CRFS	-0.833	18	0.7071		**CPFS**	-0.375	16	0.5	
Pair:2										
	CAPFF	-0.61	18	0.608	0.381	**CAPFF**	-0.5	16	0.516	1.00
	CRFF	-0.444	18	0.7838		**CPFF**	-0.5	16	0.6325	
Pair:3										
	CAPFT	-0.39	18	0.916	0.749	**CAPFT**	-0.25	16	0.577	0.58
	CRFT	-0.444	18	0.9218		**CPFT**	-0.188	16	0.5439	
Pair:4										
	CAPFM	-0.67	18	0.84	0.205	**CAPFM**	-0.31	16	0.479	0.164
	CRFM	-0.944	18	0.8024		**CPFM**	-0.188	16	0.4031	
Pair:5										
	CAPFC	-0.11	18	0.471	0.269	**CAPFC**	-0.31	16	0.479	**0.041**
	CRFC	-0.278	18	0.4609		**CPFC**	0.57	14	0.4425	
Pair:6										
	L. or Dl.	0.8	15	1.207	0.25	**L. or Dl.**	0.57	14	0.646	0.104
	L. or Dl.	0.333	15	0.9759		**L. or Dl.**	0.857	14	0.7703	
Pair:7										
	OQCAPF	2.93	15	1.668	0.567	**OQCAPF**	3.85	13	0.801	0.584
	OQCRF	3.133	15	0.9155		**OQCAPF**	4	13	0.8165	

Table 4.4 shows the results of sample paired t-test for battered fried fish comparing APF to RF on the left side, and APF to PF on the right side. On the left side, the only significant difference was in the color condition with pair 5 (CFAPFC/CFRFC, $p< 0.096$); and, on the right side of the table, there were two significant differences in pairs 4 and 5, FAPFM/FPFM (fish all-purpose flour moisture/fish potato flour moisture) $p<0.017$, and FPFC/FPFC (fish all-purpose flour color/fish potato flour color) $p < 0.05$.

Table 4.4c

Fish

	APF/RF					APF/PF			
		M	**n**	**SD**	**P**		**M**	**n**	**SD**	**P**
Pair:1										
	CFAPFS	-0.78	23	0.795	0.171	**FAPFS**	-0.27	26	0.724	0.134
	CFRFS	-0.565	23	0.7278		**FPFS**	-0.077	26	0.5602	
Pair:2										
	CFAPFF	-0.35	23	0.647	0.788	**FAPFF**	-0.48	27	0.58	0.404
	CFRFF	-0.304	23	0.5588		**FPFF**	-0.333	27	0.6202	
Pair:3										
	CFAPFT	-0.04	23	0.638	0.665	**FAPFT**	-0.07	27	0.616	0.294
	CFRFT	-0.087	23	0.5964		**FPFT**	-0.222	27	0.50964	
Pair:4										
	CFAPFM	-0.05	21	0.669	0.576	**FAPFM**	-0.15	27	0.362	**0.017**
	CFRFM	-0.143	21	0.6547		**FPFM**	0.185	27	0.5573	
Pair:5										
	CFAPFC	-0.04	23	0.367	**0.096**	**FAPFC**	-0.32	25	0.557	**0.05**
	CFRFC	-0.261	23	0.449		**FPFC**	-0.04	25	0.3512	
Pair:6										
	L. or Dl.	0.65	20	0.988	0.234	**L. or Dl.**	0.71	24	0.859	0.739
	L. or Dl.	0.9	20	1.0208		**L. or Dl.**	0.792	24	0.824	
Pair:7										
	OQCAPF	3.67	21	0.966	0.452	**OQCAPF**	3.63	24	0.824	0.285
	OQCRF	3.81	21	0.8729		**OQCRF**	3.833	24	0.7614	

Table 4.4d shows the comparison of battered fried shrimp using APF, RF, and PF. The only significant difference was found in pair 4: SAPFM/ SPFM (shrimp all-purpose flour moisture / shrimp potato flour moisture) with $p < 0.018$.

Table 4.4d

Shrimp

	APF /RF					APF / PF				
		M	**n**	**S.D.**	**P**		**M**	**n**	**S.D.**	**P**
Pair: 1										
	SAPFS	-0.08	25	0.4	0.327	**SAPFS**	-0.379	29	0.4938	0.787
	SRFS	-0.2	25	0.4082		**SPFS**	-0.414	29	0.568	
Pair: 2										
	SAPFF	-0.32	25	0.476	0.327	**SAPFF**	-0.25	29	0.441	0.326
	SRFF	-0.48	25	0.5099		**SPFF**	-0.357	29	0.488	
Pair: 3										
	SAPFT	-0.2	25	0.5	0.491	**SAPFT**	-0.138	29	0.4411	0.537
	SRFT	-0.12	25	0.526		**SPFT**	-0.207	29	0.4913	
Pair: 4										
	SAPFM	-0.04	25	0.351	0.664	**SAPFM**	-0.069	29	0.3714	**0.018**
	SRFM	0	25	0.5774		**SPFM**	0.207	29	0.5593	
Pair: 5										
	SAPFC	-0.04	25	0.351	0.664	**SAPFC**	-0.034	29	0.1857	0.573
	SRFC	0	25	0.2887		**SPFC**	0	29	0.2673	
Pair: 6										
	L. or Dl.	1.26	19	0.562	0.494	**L. or Dl.**	1.077	29	0.5602	0.207
	L. or Dl.	1.158	19	0.6021		**L. or Dl.**	0.846	29	0.9672	
Pair: 7										
	OQSAPF	4.06	17	0.748	0.543	**OQSAPF**	3.88	29	0.8813	1.000
	OQSRF	3.941	17	0.7475		**OQSPF**	3.88	29	1.0132	

Table 4.4e shows collected data using paired sample t-test. Battered fried pork comparing APF to RF showed significant difference in PAPFM (pork all-purpose flour moisture)/PRFM (pork rice flour moisture) with $p<0.004$. There were three significant differences in section of APF/PF, PAPFT/PPFM (pork all-purpose flour texture/pork potato flour texture) with $p < 0.001$, PAPFM/PPFM (pork all-purpose flour moisture/pork potato flour moisture) with $p < 0.004$, and PAPFC/PPFC (pork all-purpose flour color/pork potato flour color) with $p < 0.001$.

Table 4.4e

Pork

	APF /RF					APF / PF				
		M	**n**	**S.D.**	**P**		**M**	**n**	**S.D.**	**P**
Pair: 1										
	PAPFS	-0.25	24	0.442	0.539	**PAPFS**	-0.148	27	0.864	0.227
	PRFS	-0.167	24	0.637		**PPFS**	0.074	27	0.7808	
Pair: 2										
	PAPFF	-0.42	24	0.584	0.604	**PAPFF**	-0.407	27	0.8884	0.059
	PRFF	-0.333	24	0.5647		**PPFF**	-0.074	27	0.7299	
Pair: 3										
	PAPFT	-0.17	24	0.565	0.524	**PAPFT**	-0.37	27	0.926	**0.001**
	PRFT	-0.042	24	0.9079		**PPFT**	0.148	27	0.6624	
Pair: 4										
	PAPFM	-0.04	24	0.69	**0.004**	**PAPFM**	-0.741	27	0.7121	**0.004**
	PRFM	-0.583	24	0.5836		**PPFM**	-0.222	27	0.698	
Pair: 5										
	APFC	-0.26	23	0.541	0.426	**PAPFC**	-0.148	27	0.456	**0.001**
	PRFC	-0.174	23	0.3876		**PPFC**	0.333	27	0.6202	
Pair: 6										
	L. or Dl.	0.82	22	0.853	0.131	**L. or Dl.**	0.333	24	0.9631	0.477
	L. or Dl.	0.109	22	0.9591		**L. or Dl.**	0.5	24	0.8847	
Pair: 7										
	OQPAPF	3.52	21	1.123	0.602	**OQPAPF**	3.292	24	0.6903	0.17
	OQPRF	3.381	21	0.5896		**OQPPF**	3.5	24	0.6594	

Table 4.4f shows the analyzed data of battered fried beef when comparing APF to RF and APF to PF. There was a significant difference in the APF/RF comparison in pair 1, BAPFS (beef all-purpose flour saltiness) compared to BRFS (beef rice flour saltiness) with $p < 0.056$. In the comparison section of APF/PF, there were three significant differences: pair 1, BAPFS (beef all-purpose flour saltiness)/BPFS (beef potato flour saltiness) with $p < 0.031$; pair 2, BAPFF (beef all-purpose flour flavor)/BPFF (beef potato flour flavor) with $p < 0.005$; and pair 3, BAPFM (beef all-purpose flour moisture)/BPFM (beef potato flour moisture) with $p < 0.088$.

Table 4.4f

Beef

	APF / RF					APF /PF				
		M	**n**	**S.D.**	**P**		**M**	**n**	**S.D.**	**P**
Pair: 1										
	BAPFS	0.05	20	0.394	**0.056**	**BAPFS**	-0.42	24	0.717	**0.031**
	BRFS	-0.2	20	0.4104		**BPFS**	0.083	24	0.7755	
Pair: 2										
	BAPFF	-0.2	20	0.41	0.379	**BAPFF**	-0.7	23	0.559	**0.005**
	BRFF	-0.35	20	0.6708		**BPFF**	-0.217	23	0.6713	
Pair: 3										
	BAPFT	-0.11	18	1.023	0.805	**BAPFT**	-0.13	24	0.85	0.405
	BRFT	-0.056	18	0.9984		**BPFT**	-0.292	24	0.7506	
Pair: 4										
	BAPFM	-0.16	19	0.602	0.804	**BAPFM**	-0.54	24	0.833	**0.088**
	BRFM	-0.105	19	0.6578		**BPFM**	-0.208	24	0.779	
Pair: 5										
	BAPFC	0.1	20	0.308	0.716	**BAPFC**	0.04	24	0.806	0.503
	BRFC	0.05	20	0.6048		**BPFC**	0.167	24	0.4815	
Pair: 6										
	L. or Dl.	0.47	19	0.841	1.000	**L. or Dl.**	0.37	19	0.831	0.167
	L. or Dl.	0.474	19	0.9643		**L. or Dl.**	0.737	19	0.8057	
Pair: 7										
	OQBAPF	3.42	19	0.902	0.385	**OQBAPF**	3.26	19	0.733	0.111
	OQBRF	3.632	19	1.0116		**OQBPF**	3.579	19	0.6925	

Research Question 6: Are there any differences in calorie, fat, and protein content among protein rich foods battered in wheat, rice, and potato flours?

For Research Question 6, samples of battered fried chicken, fish, shrimp, pork, and beef used all three types of flours (APF, RF, PF) on each luncheon day. These were sent to the Central Analytical Laboratory of a large Mid-South institution to analyze calories, fat, and protein contents for each sample. After samples were sent to the Analytical Laboratory, batter fried chicken, fish, shrimp, pork, and beef were dried, ground, then analyzed for calories, fat, and protein content. Each analysis was done under certain protocol based on AOAC (Association of Official Analytical Chemists) quantified procedures. The data was calculated and reported on as is basis.

Table 4.4 shows this data, comparing calories (gram) of different protein rich foods chicken, fish, shrimp, and pork (excluding beef), battered with different flour types. Chicken, fish, shrimp, and pork battered with the RF contained the lowest calories; among them: chicken/RF = 2982, fish/RF = 2025, and shrimp/RF = 2426. The number of calories in the battering system in all chicken, fish, shrimp, and pork (excluding beef) was higher using PF.

Proteins and fats percentages in the food samples were also analyzed for this part of the study. Protein percentage in battered fried chicken was highest with APF (24.8%), fish with RF (16.3%), shrimp with PF (14.0%), pork with RF (21.4%), and beef with APF (25.2%). Fat percentages were highest in chicken with APF (18.2%), followed by fish with PF (12.9%), shrimp with PF (23.5%), pork with PF (19.1%), and beef with PF (18.0%). The lowest amounts of fat (%), belonged to the RF classification (10.4%, 6.45%, 13.3%, 11.1%, and 14.5%, respectively) in all protein rich foods compared to APF and PF; proving that rice flour was less absorbent than APF and PF, which was one of the purposes of this study.

Samples that had been sent to the Poultry Science Laboratory were too small and for that reason it was not possible to generalize the result.

Table 4.5
Nutrient Composition

	Chicken			Fish			Shrimp			Pork			Beef			All		
	APF	**RF**	**PF**	**APF**	**RF**	**PF**	**APF**	**RF**	**PF**	**APF**	**RF**	**PF**	**APF**	**RF**	**PF**	**APF**	**RF**	**PF**
Protein (%)	24.8	24.2	23.3	15.9	16.3	25.2	20.9	18.0	14.0	19.3	21.4	20.5	25.2	20.9	18.0	16.4	15.9	14.6
Fat (%)	18.2	10.4	16.0	12.0	6.45	14.6	14.5	13.3	23.5	14.3	11.1	19.1	14.6	14.5	18.0	12.6	9.3	14.9
Calories	3.63*	2.98	3.09	2.41	2.02	2.15	3.73	2.42	3.45	2.74	2.60	3.56	2.91	3.13	3.06	2.40	2.19	2.55

*3633 / 1000 = 3.63 kcal /gram (same calculation was applied for all calories in this table)

Note: Samples are reported on an ‘as is’ basis.

CHAPTER 5

DISCUSSION

Summary of Findings

The purpose of this study was to establish and develop a more in-depth perspective regarding healthy food choices. This study provided information about the nutritional value of chicken, fish, shrimp, pork, and beef that were battered and pan fried using three different flours (all-purpose flour, rice flour, and potato flour), plus establish the liking/disliking and overall quality preferences in regard to battered fried chicken, fish, shrimp, pork, and beef.

Previous chapters elaborated on the research methodologies and statistical analyses that were used to discuss the test results. This chapter provides a summary of the study and conclusions as they relate to the six research questions, followed by discussions of specific findings.

The sample used in this study consisted of 16 students who were enrolled in Menu Layout and Food Preparation Laboratory class (pilot test), and luncheon guests (every Monday and Wednesday) during a five-week period (primary test); all were between the ages of 18 and 65.

Research Questions 1 & 2: Do participants have preferences for fried food based on flour type? Does this preference vary by protein type?

To answer Research Questions 1 & 2 as a whole, first APF was compared to RF in battered protein rich foods. The result for the first part showed that 68.75% of respondents' preferred fried chicken battered with APF, only 31.25% preferred chicken battered with RF, which also was significant; 52.63% preferred fried fish battered with APF compared to rice flour

with 47.36%; fried shrimp with APF were preferred by 59.09% and 40.90% with RF; 63.63% preferred fried pork with APF and only 36.36% with RF, which were significant findings; and 34.61% of respondents preferred fried beef with APF and 26.92% with RF. Additionally, when comparing "All" APF to RF, 60% preferred APF, and 40% RF, which also was significant in the comparison. Based on these findings, respondents preferred all five fried protein rich foods battered with APF for the first part of the question (Tabled 4.1).

Second, APF was compared to PF based on all protein types. The results showed that 46.66% of respondents preferred fried chicken battered with APF and 53.33% with PF; 46.15% preferred fried fish battered with APF and 53.84% preferred PF; 40.74% preferred fried shrimp battered with APF and 59.25% preferred PF, which was significant; 38.46% preferred fried pork with APF and 61.53% with PF, which was significant as well; and 23.80% preferred fried beef with APF and 76.19% with PF, also significant. In addition, when comparing all APF to PF, 39.10% preferred APF and 60.90% preferred PF, which was a significant finding (Table 4.1).

In conclusion, the results showed that respondents to the first and second question about their preferences of battered fried food when comparing APF, RF, and PF were listed in the following order: potato flour, all-purpose flour, rice flour. In the case of all five protein rich foods used in this study: chicken, fish, shrimp, pork, and beef, respectively.

Additionally, based on different protein types in the case of fish, shrimp, and beef, there was not a significant difference comparing APF to RF. This result showed that participants did not mind that these protein rich foods were battered with RF, if they were offered as being better options. In regard to comparing APF/ PF, participants preferred mostly the PF, but in the case of chicken and fish the differences were not significant.

Research Questions 3a & 3b: Is there a difference in quality perception among flour type? Do quality perceptions also vary by protein type?

As far as quality perception, the analyzed data were included in six tables (see Tables 4.2a-4.2f), which compared all flour types (APF, RF, and PF) and chicken, fish, shrimp, beef, and pork. A paired samples t-test was conducted to show the difference of quality perception among flour types and all different protein types.

First, the APF was compared to RF and PF in regard to sensory evaluations (saltiness, flavor, texture, moisture, and color). There was almost no significant difference in the quality preference between APF and RF except a slight difference in the rice flour moisture. It seems that the moisture, which was an important element in battered fried food, was also a preference of the participants' tasting the rice flour.

Comparing APF to PF, there were several significant differences in saltiness, flavor, moisture, and color causing a significant difference in the quality perception of the potato flour. Respondents' preferred fried chicken, fish, shrimp, pork, and beef battered with potato flour compared to all-purpose flour.

In the case of chicken, fish, shrimp, pork, and beef, APF was compared to RF and PF, in regard to quality preference looking at the different elements of saltiness, flavor, texture, moisture, and color.

Chicken: APF compared to RF showed no significant difference in quality perception of respondents, and APF compared to PF showed only one significant difference in the color element, which was a respondent's preference. It seemed that participants had no preference in sensory evaluation regarding chicken battered with APF and RF.

Fish: APF to RF showed a slight significance in color more toward the APF, and in comparison of APF to PF moisture and color of PF were preferred, but no significant difference in quality perception in regard to sensory evaluation.

Shrimp: Results indicated no significant difference comparing APF to RF in quality, and one significant difference comparing APF to PF in moisture (in favor of PF), but no quality perception difference.

Pork: Data indicated a significant difference in moisture when comparing APF to RF in favor of RF, and several significant differences in saltiness, flavor, and moisture elements in comparison of APF/PF, but no significant difference in quality preference.

Beef: Data showed a slight significance in RF in saltiness when comparing APF to RF, but showed several significant differences in saltiness, flavor, and moisture elements in PF. There was no significant difference in quality preference.

In summary, analyzed data for this research question indicated that only in the "All" category was there a significant difference in quality perception when comparing APF to PF, which meant that respondents tended more toward the potato flour, especially in saltiness, flavor, moisture, and color. More importantly, in regard to quality perception comparing APF to RF, there was no preference between these two among participants' sensory evaluations.

Research Question 4: What are the liking differences by flour and protein type?

Analyzed data for the liking differences of the respondents showed that chicken with PF, compared to APF and RF, was more popular, which meant respondents liked fried chicken battered with PF more than with APF or RF. In the case of battered fried fish, respondents liked battered fried fish with RF. In the case of shrimp, the highest number belonged to APF, meaning

that the respondents liking level was higher for APF when compared to RF and PF. Respondents liking level was higher in battered fried pork with APF compared to RF and PF. The last was beef battered with PF when compared to APF and RF. In summary, respondents liked chicken battered with potato flour, fish battered with rice flour, shrimp battered with all-purpose flour, pork battered with all-purpose flour, and beef battered with potato flour.

Research Question 5: Is there a difference in "just right" sensory characteristics among flour type? And among protein type?

Pairs were compared in two categories (APF/RF, and APF/PF) regarding saltiness, flavor, texture, moisture, color, likeliness, and overall quality elements. There was a significant difference in the scores for moisture when comparing APF to RF, but there were also several significant differences in the scores of saltiness, flavor, moisture, color, and overall quality. In conclusion, respondents found the moisture condition "just right" comparing all categories of APF to RF, also in the category of all APF compared to RF, the respondents found the saltiness, flavor, moisture, color, and overall quality in the "just right" measurement.

Chicken: There was no significant difference in the first category (APF/RF), and only one significant difference in the second category (APF/PF) in color element, which meant that the respondents only preferred the color condition in the "just right" measurement.

Fish: There was one significant difference in first category (APF/RF) of the color element and in the next category (APF/PF) of moisture and color elements, which also meant again respondents found color in the "just right" category when comparing all-purpose and rice flour, and the same in APF/PF plus the moisture in the "just right" measurement.

Shrimp: The only significant difference was in the category of APF/PF in the moisture element, respondents found the moisture in the "just right" measurement of battered fried shrimp.

Pork: In the first category (APF/RF) showed a significant difference in moisture and in the second category (APF/PF) showed significant differences in texture, moisture, and color. These findings meant that respondents found, in the first category, moisture in the "just right" measurement, and in the second; texture, moisture, and color in the "just right" measurement.

Beef: Showed a significant difference in saltiness in the first category (APF/RF), but it showed several significant differences in the second category (APF/PF) in the saltiness, flavor, and moisture elements of respondents' "just right" measurements. Meaning that respondents liked the saltiness of beef in the first category and liked the saltiness, flavor, and moisture of beef in the second category of the "just right" measurement.

Research Question 6: Are there any differences in calorie, fat, and protein content among protein rich foods battered in all-purpose, rice, and potato flours?

Results for this question were obtained from sending battered fried chicken, fish, shrimp, pork, and beef samples to the Central Analytical Laboratory (University of Arkansas). Each sample that was sent to the lab was battered and fried with all three flour types (APF, RF, and PF). The protein percentages indicated that fried chicken battered with APF was the highest protein among all flour types. Protein percentages were highest in fried battered fish with RF compared to the other flour types; the protein amount in fried shrimp battered with PF was among the highest protein percentage; and fried pork battered with RF, the highest amount of protein of fried beef battered with APF.

The amount of fat in each sample might be an indication of flour's fat absorption, which was also one of the purposes of this research. Fat percentages in all five battered chicken, fish, shrimp, pork, and beef using RF was lower than APF and PF.

Calorie was the last component. Except for fried beef battered with RF, which had the highest number of calories, chicken, fish, shrimp, and pork battered with RF had the lowest amount of calories.

Chapter Summary

A majority of respondents stated they preferred fried chicken, fish, shrimp, pork, and beef battered with APF when comparing APF to RF, and they preferred PF when comparing APF to PF. Comparing all three flour types, respondents preferred the flours in this order: PF, APF, RF.

In regard to quality perception, data did not show a significant difference except for saltiness, flavor, moisture, and color elements of PF. There was no significant difference in quality perceptions.

Based on the findings, comparing APF to both RF and PF, in regard to respondents' likes or dislikes, there were no significant differences. In the case of chicken, fish, shrimp, pork, and beef, data showed no significant difference as well.

Respondents' evaluation to the "just right" measurement determined that respondents mostly liked the potato flour's saltiness, flavor, moisture, color and quality when comparing all three types of flours. Comparing battered fried chicken, fish, shrimp, pork, and beef, respondents mostly liked potato flour's moisture, texture, and color elements as "just right"; also, rice flour's moisture and color appeared to be "just right."

Lab results measuring protein (%), fat (%), and calories indicated that rice flour when compared to APF and PF was less fat absorbent, lower in calories, and contained the highest in protein percentage, which was one of the key findings in this research study.

Based on the findings in this study, respondents preferred in the following order: both chicken and beef battered with potato-flour, fish with rice-flour, and both shrimp and pork with all-purpose flour. The significant differences in the case of overall quality and liking level were mostly in moisture and color of the fried food or not a significant difference at all. Participants also preferred mostly potato flour compared to the other two flour types. In the "all" category comparing all flours and chicken, fish, shrimp, pork, and beef; respondents preferred the moisture element of rice flour and the saltiness, flavor, and moisture elements of potato flour in most cases.

Additionally, the empirical findings of this study were regarding calories, fat content and protein percentages as a result of analyzed samples sent to Central Analytical Laboratory. These findings supported the idea of using rice flour as a healthier choice by showing that rice flour was a less fat absorbent option.

CHAPTER 6

CONCLUSION

This study examined participants' preferences and their sensory evaluations regarding three types of flours (all-purpose, rice, and potato flour) and chicken, fish, shrimp, pork, and beef using a quantitative survey. At the same time, the study investigated protein, calorie, and fat content of the battered fried chicken, fish, shrimp, pork, and beef comparing all three types of flours analyzed in the Central Analytical Laboratory at the University of Arkansas. The results of these two parts of this study were combined to provide information regarding better food choices to meet both people's preferences and interests, and their health conditions.

Key Findings

- Participants generally preferred all-purpose flour (APF) to rice flour (RF), and PF (potato flour) to APF.
- Participants did not have any preference regarding fish, shrimp or beef battered in either APF or RF, but preferred chicken and pork with PF.
- Participants did not have any preference regarding chicken and fish battered with PF or APF, but preferred shrimp, pork, and beef with PF.
- Participants' sensory evaluation for RF and APF showed equal results for chicken, fish, shrimp, pork, and beef, but they preferred the moisture sensation of RF.
- Regarding quality, participants preferred PF to APF.
- Participants, for most part, preferred PF to APF in the sensory evaluation (saltiness, flavor, moisture, and color); they did not have any texture preference.

- **Chicken:** From the sensory evaluation perspective, RF and APF were the same for all participants. However, with APF and PF they found the color to be in the "just right" measurement. Participants preferred chicken battered with PF. On the other hand, chicken battered with APF had more protein. And, chicken with RF had lower fat and calorie content.
- **Fish:** The sensory evaluation showed the same preference for both RF and APF, with exception of the APF color. The sensory evaluation between APF and PF was the same, but moisture and color of PF was preferred. Participants preferred fish with RF; whereas, fish battered with RF had more protein and lower fat and calorie content compared with the other flours.
- **Shrimp:** The sensory evaluation showed the same preference for shrimp battered with RF and APF. When comparing APF and PF, participants just preferred the moisture of PF, but other factors were perceived to be the same. Mostly, they liked shrimp with APF. The protein measurement of the shrimp battered in PF was higher than with the other types of flour. Calorie and fat content of shrimp battered in RF was lower than the other two flours.
- **Pork:** The sensory evaluation showed RF and APF were same for all participants, but they preferred the moisture of RF. When comparing APF and PF, the moisture, color, and texture of PF was significant. Participants liked pork with APF. The protein percentage of pork battered with RF was higher than the other types of batter and it had less calorie and fat content.
- **Beef:** The sensory evaluation for beef battered with APF and RF were the same, but the APF saltiness was slightly higher. When comparing APF and PF, there was a significant

difference in saltiness and flavor, but only slightly with moisture. Participants preferred the beef with PF. The beef with APF had more protein content, and RF had less fat compared to the other flours.

Conclusion

Participants of this study tasted chicken, fish, shrimp, pork, and beef battered with three types of flours (APF, RF, and PF). The results showed that they preferred PF to APF and APF to RF; however, overall they preferred the chicken, fish, shrimp, pork, and beef battered with APF. This may be due to the respondents' familiarity with the taste of all-purpose flour as the traditional flour used for years as the main batter ingredient. According to the laboratory results, chicken, fish, shrimp, pork, and beef battered with RF had less fat when compared with the other flour batters. This finding confirmed the findings of Dogan et al. (2014) about rice flour being less oil absorbent than APF and Lee et al. (2012) suggesting RF as a good substitute for APF. The number of calories was less in chicken, fish, shrimp, and pork when battered with RF; only beef had more calories when battered with RF. According to Bos et al. (2013), the accessibility and availability of healthier low-calorie food was important for people, so the results of this research could offer easier access to healthier food choices for people.

People preferred chicken with PF, but when based on sensory evaluation (saltiness, flavor, texture, moisture, and color) they did not have any particular preference; therefore, people could use RF as a substitute if they were informed that it had lower fat and calories. Fish with RF was the healthiest choice among the flours, and based on sensory evaluation, participants had no preference over the other kinds of flour when compared to RF. Therefore, this is maybe a good alternate flour choice. Even though participants' preferred shrimp battered with APF, from a

nutritional perspective, RF may be a better option as it contained lower levels of fat and calories; whereas, PF could be a choice for a higher protein percentage. Participants preferred pork battered with APF; but, RF would be the healthiest choice for them. Regarding beef, the preferred healthy flour choice was difficult decision to make. Despite all the facts, that rice flour would be a better alternative to all-purpose flour when used for battered fried food, and, whereas, the potato flour was preferred by most of the participants, the results of this study would recommend the substitution of the two alternatives. Another aspect of this recommendation would be that both these flours were gluten free.

This study's information could increase people's knowledge about rice flour as a better and healthier food decision without losing the good taste and other sensory factors of the food.

Implications

Despite the fact that fried food is a very convenient method of cooking for both families and the food industry, people are becoming more aware and concerned about their diet and its effect on their health. Especially, because what people eat may play a big role in chronic disease prevention. The goal of this study was to obtain a deeper understanding of the factors influencing food decision-making, as well as alternative fried food preparation evaluations through comparing APF, RF, and PF in a battering system of fried protein rich foods. This study only begins to introduce the rice-flour to people's daily diet as a healthier alternative.

One of the implications of this study was the need for more awareness of rice and rice products as a healthier substitution to all-purpose flour.

The perception and definition of healthy food of experts and non-experts was another very important implication of this research paper.

Future Research

It is recommended that, based on the results of this study, more studies need to be conducted to find an overall and local examination of factors driving dietary choices. Additionally, there needs to be a recommendation for studies to examine the relationship between age, ethnicity, educational level, origin, and culture; and their effects on food choices.

An additional study could be based on factors effecting food choices such as food cost and healthy food accessibility and or economic consequences of nutritional and health outcomes.

Still, another very important study could be the local food system and food service industry and their responsibilities toward their consumer's health, along with market incentives, government policies and regulations in regard to meat and poultry.

Limitations

One of the strengths of this study was its focus on three types of flours used to batter chicken, fish, shrimp, pork, and beef. The second strength of this study was the sample (Bezerra, Curini, & Sichieri, 2012) size (235) and the diversity in regard to age, degree level, and origin. Findings demonstrated quite complex relationships between all the factors used in this study. This study was done to help people at home as well as in the full service restaurants to create or offer healthier food choices especially in the case of fried battered protein rich foods, and also for the new trend of menu labeling and nutritional facts information on the menus.

There were limitations to this study such as food cost, being limited to Northwest Arkansas, limitations of focus on the level of cultural connections in regard to battered fried food, and concern over the arsenic level of rice not being addressed in this study.

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Appendix A

Alternative Fried Food Preparation Evaluation
Information Letter

Dear Potential Participant,

You are invited to take part in the research project identified above which is being conducted by the Research Team of Lobat Siahmakoun, Robert J. Harrington, and Allen Powell at the University of Arkansas.

This research project examines the potential of alternative flours and fried food preparation using a 5-point scale for product characteristics (saltiness, flavor, texture, moisture, and color), product liking, quality and preference. It is anticipated that the findings from this research will contribute to the body of knowledge on fried food preparation using alternative methods.

Who can participate in the research?
Anyone may participate in this research, who is at least 18 years old and in good health.

What choice do I have?
Participation is **entirely voluntary**. If you decide to participate, you may withdraw from the project at any time without giving a reason and without any penalty. The researcher(s) may also withdraw a participant if it is considered in the participant's best interest or it is appropriate to do so for another reason. If this happens, the research(s) will explain why and advise you about any follow-up procedures or alternative arrangements as appropriate.

All information collected will be confidential. All information collected will be stored securely with the researchers and until destroyed after coding and entry into a data file in Hospitality & Restaurant Management, School of Human Environmental Sciences, College of Agricultural, Food and Life Sciences, Fayetteville, AR 72701.

At no time will any individual be identified in any reports resulting from this study.

What will I be asked to do?
Participate in a one-time fried food evaluation session lasting approximately 10 minutes in duration. As part of this process, you will be asked to assess the level of liking and quality for two fried food items.

Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study. The names of members in this study will be kept confidential during data analysis or subsequent publication of study results. Sensory evaluation survey forms will be given an ID code prior to statistical analysis. No names or identifying information will be included in the written report.
- Analysis of aggregate data from the completed sensory evaluation survey forms will be summarized in a written report.

- Should a participant not be able to participate in one or more components based on the personal reasons, they may do so.

What are the risks and benefits of participating?
There are no anticipated risks to this research; however, because participants will be tasting food items, the ingredients of all food products will be disclosed prior to tasting. All participants will be required to notify the investigators of any allergies to food items.

While the amount of food ingested at any tasting session will be minimal, participants should evaluate their personal situation prior to consenting to participation in the sensory tasting session.

Participants with sensitivities to wheat products, gluten, rice products, chicken, shrimp, pork or fried foods in general will be excluded from sessions containing these food products.

The benefit received from participation in this study includes increased appreciation for sensory evaluation and greater knowledge in sensory analysis as applied to fried food. Your participation benefits society by furthering the knowledge of alternative fried food methods that impact health, calories and the use of local food products.

How will the information collected be used?

The data provided will be used in the research on rice flour as an alternative to wheat flour, and will form part of a written report. If a participant requests a copy of the report, it will be sent via email.

What do I need to do to participate?
Please read this Information Letter and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have any questions, please contact the
Principal Investigator or Co-Researchers.

>rharring@uark.edu or 479-575-4700.

If you would like to participate, please sign the required Consent Form.

Thank you for considering this invitation,

Lobat Siahmakoun, Masters Candidate

Robert J. Harrington, PhD, Professor and Endowed Chair
rharring@uark.edu or 479-575-4700.

Allen Powel, MS, Instructor in Hospitality & Restaurant Management
apowell@uark.edu or 479-575-4689

Appendix B

Alternative Fried Food Preparation Evaluation Survey

1. **Gender:** ____ Male ____ Female

2. What is your age range?

18 – 24	25 – 34	35 – 44	45 – 64	65 or Older
☐	☐	☐	☐	☐

3. What is your Ethnicity/Race?

American Indian	Asian or Pacific Islander	Black/African American	White/Caucasian	Other
☐	☐	☐	☐	☐

4. What is the highest degree or level of education completed?

High School	Bachelor's Degree	Master's Degree	Doctorate
☐	☐	☐	☐

5. What is your Country: _____ State: _____Hometown:_____

3. Self-Assessment: **How is your health status in general?**

Very bad	Bad	Neither bad nor good	Good	Very good
☐	☐	☐	☐	☐

4**.** Self-Assessment: **How is your smell function in general?**

Very bad	Bad	Neither bad nor good	Good	Very good
☐	☐	☐	☐	☐

5. Self-Assessment: **How is your taste function in general?**

Very bad	Bad	Neither bad nor good	Good	Very good
☐	☐	☐	☐	☐

6. How often do you consume **fried food**?

Never	Once per month	Once per week	2-3 times per week	4 or more times per week
☐	☐	☐	☐	☐

7. Allergy: **Do you have any allergies to foods, odors, or drinks?**

_____ No
_____ Yes: I have allergies to _____.

Item A_____

Protein

	Not At All	**Not quite enough**	**Just Right**	**A Little Too Much**	**Too Much**
Saltiness					
Flavor					
Texture					
Moisture					
Color					

1. How much do you like or dislike the food Item?

Dislike extremely ☐ Dislike moderately ☐ Neither dislike nor like ☐ Like moderately ☐ Like extremely ☐

2. How would you rate the overall quality of the food Item?

Very poor ☐ Poor ☐ Average ☐ Good ☐ Excellent ☐

Item B (with toothpick) _____

Protein

	Not At All	**Not quite enough**	**Just Right**	**A Little Too Much**	**Too Much**
Saltiness					
Flavor					
Texture					
Moisture					
Color					

1. How much do you like or dislike the food Item?

Dislike extremely ☐ Dislike moderately ☐ Neither dislike nor like ☐ Like moderately ☐ Like extremely ☐

2. How would you rate the overall quality of the food Item?

Very poor ☐ Poor ☐ Average ☐ Good ☐ Excellent ☐

3. If you had to choose, which item is your preference: Item A_____ or Item B_____

Appendix C

Alternative Fried Food Preparation Evaluation
Consent Form

I, (please print) _____have read and understand the information on the research project "**Alternative Fried Food Preparation"** conducted by Ms. Lobat Siahmakoun, Dr. Robert J. Harrington & Mr. Allen Powell. All questions have been answered to my satisfaction; I agree to voluntarily participate in this research and give my consent freely.

I understand that the project will be conducted in accordance with the information letter, a copy of which I have retained for my records. I understand I can withdraw from the project at any time and do not have to give any reason for withdrawal.

I consent to participate in a one-time food sensory evaluation lasting approximately 10 minutes in duration. As part of this process, you will be asked to assess the level of liking and quality for two fried food items.

Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study. The names of members in this study will be kept confidential during data analysis or subsequent publication of study results.

Sensory evaluation survey forms will be given an ID code prior to statistical analysis. No names or identifying information will be included in the written report.
- Analysis of aggregate data from the completed sensory evaluation survey forms will be summarized in a written report.
- Should a participant not be able to participate in one or more components based on the personal reasons, they may do so.

Print Name: _____

Signature: _____

Date: _____

Appendix D

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

March 12, 2015

MEMORANDUM

TO:	Lobat Siahmakoun Robert Harrington Frank Allen Powell
FROM:	Ro Windwalker IRB Coordinator
RE:	PROJECT CONTINUATION
IRB Protocol #:	14-02-544
Protocol Title:	*Alternative Fried Food Preparation Evaluation*
Review Type:	☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB
Previous Approval Period:	Start Date: 03/18/2014 Expiration Date: 03/17/2015
New Expiration Date:	03/17/2016

Your request to extend the referenced protocol has been approved by the IRB. If at the end of this period you wish to continue the project, you must submit a request using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. Failure to obtain approval for a continuation on or prior to this new expiration date will result in termination of the protocol and you will be required to submit a new protocol to the IRB before continuing the project. Data collected past the protocol expiration date may need to be eliminated from the dataset should you wish to publish. Only data collected under a currently approved protocol can be certified by the IRB for any purpose.

This protocol has been approved for 210 total participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.

109 MLKG • 1 University of Arkansas • Fayetteville, AR 72701-1201 • (479) 575-2208 • Fax (479) 575-6527 • Email irb@uark.edu