Physicochemical, Microbiological and Sensory Properties of Yoghurt Processed by Addition of Rice Flour

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Date of Examination: 21 / 12 / 2017
DEDICATION

TO My...

Father,

Mother,

Teachers,

Aunt and uncle

Brother, Sisters and Friends
ACKNOWLEDGEMENT

Thanks, and gratitude is first to Allah my lord the merciful for the health, strength and patience to conduct this work. With sincere respect and gratitude, I would like to thank my principal supervisor Dr. Zakaria Ahmed Salih for his keen supervision encouragement, support and guidance throughout of this Study. My sincere thanks are extended to my Co–supervisor Dr. Azhari Siddeeg Abdelwahab for his invaluable help, advice and continuous encouragement all throughout the study period. Thanks to staff of Alrhmma factory for help and support. Special thanks to my family for making my life bright and hopeful father and mother Raja Ahmad, for support, tolerance at moments of difficulties and my brothers Ahmad, Ali and my sisters Amna, Zainab, and my uncles. Deep appreciation and thanks to my fiancé, and my best friends Sara, Rabab, Haifaa, Tamany for their assistance and encouragement. Finally, many thanks extended to others who offered help in one way or another.
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ABSTRACT

Rice is a dietary staple food and one of the most important cereal crops, especially in Asia. Rice flour is used in sweets, crackers, bread, and thickening agent. The aim of this study is to assess the nutritional value and texture of the yoghurt with addition of different concentrations of rice flour. Yoghurt samples were processed by adding rice flour at 0, 2, 4 and 6%. Standard methods were used to determine the physicochemical, microbiological and sensory analysis of all yoghurt samples. The results indicated that the highest moisture content in control sample was 86.86% and the lowest one in 6% was (84.41%) of rice flour. The protein content of yoghurt samples was 4.16, 4.20, 4.57 and 4.83%, the protein contents increase significantly \((p<0.005)\) by addition of rice flour. The fat content in yogurt samples was 2.19, 2.21, 2.21 and 2.23% in control, 2, 4 and 6%, respectively. The mineral content were not affected significantly \((p<0.005)\) by the added rice flour. The ash content was 0.26, 0.35, 0.52 and 0.72% in control, 2, 4 and 6%, respectively and increase significantly \((p<0.005)\) by the addition of rice flour. Titratable acidity decreases significantly \((p<0.005)\) while the pH value increases by the added rice flour. The highest viscosity of yoghurt samples is in control sample which is 4212 cps and the lowest in 6% is 3766 cps. The serum separation of yoghurt samples with rice flour was (5.32, 4.47, 4.20 and 3.70 ml) respectively, which decrease significantly \((p<0.005)\), while the dry matter of yoghurt sample increase by addition rice flour, the highest one was recorded in yoghurt sample produced by 6% was (15.42 %) by rice flour . The microbiological analysis of yoghurt samples indicated the total count bacteria, mould and yeast was not affected significantly \((p<0.005)\) by the addition of rice flour and no growth of \textit{coliform} and \textit{Salmonella}. The sensory evaluation indicated that yoghurt samples with 4% rice flour is the highest consumer acceptability scores. This study recommends that further Studies for understanding more physical properties of processed yoghurt by adding of rice flour during refrigerated storage.
الخصائص الفيزيوكيميائية والميكروبيولوجية والحسية للسبادي المصنوع بإضافة دقيق الأرز

ملخص الدراسة

الأرز هو من المواد الغذائية الأساسية من محاصيل الحبوب الرئيسية، خاصة في أسا، دقيق الأرز يستخدم في الحلويات والسكريات والخبز كعامل سماكة. والهدف من هذه الدراسة هو تقييم القيمة الغذائية والقيم للزيت الزيتى بإضافة تراكيز مختلفة من دقيق الأرز. صممت عينات الزيتى بإضافة دقيق الأرز بنسبة 0،2،4،6% تم استخدام الطرق القياسية في هذا البحث لتحديد التحليل القيوكيميائي، الميكروبيولوجي، والحسى لجميع عينات الزيتى. أشارت النتائج إلى أن أعلى نسبة رواسب كانت في العينة الشاهد 86.86% وأقل نسبة كانت في 6% (84.41%) من دقيق الأرز. محتوى البروتين في عينات الزيتى كان (4.16، 4.20، 4.47، 4.35) ونسبة محتوى البروتين معنوية (P<0.005) بإضافة دقيق الأرز. كان محتوى الدهن في عينات الزيتى (19.23، 21.21، 21.19%) في 0.6، 4.2% على التوالي. ولم يكن محتوى الدهن تأثيراً معنوية (P>0.005). كان محتوى الرمال (26، 35، 52، 72%) ونسبة المحتوى العام معداً بدرجة كبيرة (P<0.005) بواسطة دقيق الأرز. انخفضت الحمضية (P<0.005) في حين ازدادت قيمة ال pH. في عينة الشاهد، كانت أكثر من 6% كانت cfs 4212. انفصال المصل الزيتى المصنوع بإضافة دقيق الأرز كان (P<0.005) في التوالي، ولذلك نقص بشكل ملحوظ (P<0.005) بينما والمادة الجافة لعينات الزيتى زادت بزيادة إضافة دقيق الأرز. وكان أعلى نسبة في 6% (42.42%) . وأظهر التحليل الميكروبيولوجي لعينات الزيتى أن العديد الكلي للبكتيريا والعنق والخمرة لم يحدث تأثيراً معنوية (P>0.005) بإضافة دقيق الأرز، ولا يوجد نمو لبكتيريا القولون والسامولونيا. وأشار التقييم القياسي إلى أن عينات الزيتى مع دقيق الأرز بنسبة 4% أخذت أعلى درجات قبول من قبل المستهلكين. توصي الدراسة بالمزيد من دراسة التحاليل الفيزيوكيميائية للزيتى المصنوع بإضافة دقيق الأرز أثناء التخزين المبرد.
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List of abbreviations

TA : Titratable acidity.
TS : Total solid.
RDA : Recommended Dietary Allowance.
Ppm : Part per million.
C.F. U : Colony forming units.
TBC : Total bacterial count.
PDA : Potato Dextrose Ager.
FAO : Food and agriculture organization.
ANOVA : Analysis of variance.
AOAC : Association of agriculture chemist.
SPSS : Significance program statistics.
APHA : American public Health Association.
1. Introduction

Definition of Yogurt is a cultured dairy product that can be made from whole, low fat or skim milk, including reconstituted nonfat dry milk powder. Yogurt is one of the oldest fermented milk products known (Kagan, 1985).

Yogurt is made by inoculating certain bacteria (starter culture), usually *Streptococcus thermophilus* and *Lactobacillus bulgaricus*, into milk. After inoculation, the milk is incubated at approximately 110°F until firm the milk is coagulated by bacteria-produced lactic acid. Yogurt is made from the milk of water buffalo, yak, goat, horses and sheep (FDA, 2013).

Manufacturing of yogurt is an ancient technique, which dates back to thousands of years, and the knowledge has transferred generation to generation. However, during the last few decades, it became more rational due to improvement of various field much as microbiology, biochemistry and food engineering. Today it is a complex activity combined with art and science. The generalized process of yogurt making is comprised of modifying the original composition of milk, pasteurizing the yogurt mix, fermentation at thermophilic temperatures 40-45°C (Tamime, 1999).

Health Benefits of Yogurt is a nutrient-dense food that meets a wide variety of nutritional needs at for everyone. Yogurt is a good source of protein—an average 8-ounce serving contains between 8 and 10 grams of protein, or 16 to 20 percent of the Daily Recommended Value (DRV) (Krasaekoopt and Bhatia, 2012).

Yogurt is also an excellent source of calcium. Yogurt may contain up to 35 percent of the Recommended Daily Intake (RDI) for calcium. Yogurt is low in fat and high in certain minerals and essentials vitamins, including riboflavin B2, Vitamin B12, phosphorus and potassium (Krasaekoopt, 2012).

Rice (*Oryza sativa*) is a dietary staple food and one of the most important cereal crops, especially for people in Asia, but the consumption outside Asia has increased, recently. It provides the bulk of daily calories for many companion animals and humans (Ryan, 2011).

Besides those nutritional attributes of rice and rice products, the specialties of rice starch and flour contribute to their unique applications. Rice starch granule is the smallest in size among the cereal starches and results in a smooth and creamy
texture. Its short-textured paste gives a clean taste. Rice starch and flour can provide suitable textures for a range of foods with a high natural stability and digestibility. In addition, rice flour, starch and protein can be also used as processing aid, ingredients in health food, coating agents in confectionary, water binders in small goods, expanding agents in extrusion food, flavor carriers, emulsifiers and fat replacers in dairy products and paper coating agents (Laurey, 1999).

Rice can produce beta-carotene (pro-Vitamin A) in the seed endosperm tissue as for example in Golden Rice (has a gene that produces vitamin A). Although the precise amount of beta-carotene that Golden Rice variety can produce is not clear, the fact remains that it could still be beneficial to millions of people with Vitamin-A deficiency that could possibly lead to blindness (Egawa, 1995).

Medicinal Value of rice the immense diversity of rice germ plasm is a rich source for many rice based products and is also used for treating many health-related maladies such as indigestion, diabetes, arthritis, paralysis, epilepsy and give strength to pregnant and lactating mothers (Egawa,1995).
1.2 Significance of the research

Rice is a low fat and calories ratio it is rich in fiber and other food stuffs is an important for all ages. Rice flour is used in rice vermicelli, sweets, crackers, bread, batter mix for fried food and thickening agent but in this study, it will be used in the manufacture of yogurt to improve nutritional value and texture.

1.3 Objectives

1.3.1 General objective

To assess the nutritional value and texture of the yogurt with addition of different concentrations of rice flour.

1.3.2 Specific objectives

The specific objectives are outlined as follows:

1) To prepare the rice variety this contained high level of starch.
2) To use different concentrations of rice flour in milk.
3) To process the yogurt by addition of rice flour.
4) To evaluate the microbiological analysis.
5) To assess the physiochemical properties of yogurt contains rice flour.
6) To evaluate the Sensory analysis of the processed yogurt.
CHAPTER TWO
LITERATURE REVIEW

2.1 Milk

2.1.1 Definition of milk

Milk is an important part of the human diet: for infants, it is the only source of essential nutrients. Its importance declines after weaning, so that young adolescents in the UK in 1997 consumed about 178g of milk per day (Gregory and Lowe, 2000). Worldwide, using data from the Food and Agriculture Organization, dairy production and supply (total and per capita) have increased since 1980 (Wang and Li, 2008). Consumption in China has tripled since 1982. In most countries, cow’s milk is the most common milk consumed, and there is little information on dental properties of milk other than bovine. Human milk will not be considered in this review, but has been considered elsewhere (Rugg-Gunn et al, 1993).

Now, the dairy industry is an essential part of agricultural policy in most countries, and these policies have resulted in the breeding of high producing stock and the development of effective and safe milk collection and delivery systems. Milk is also used to make cream, cheese and butter, but these are outside the scope of this review. These developments are not surprising as human milk is the only source of nutrition for newly born infants and provides sufficient energy and nutrients for rapid growth and development until at least four months. Non-human milks differ in composition from human milk but make an important contribution to the nutrition of children and, indeed, adults. Milk consumption is considered so important that provision of milk in schools is public health policy in many countries (Southgate, 2000).

2.1.2 The nutritional value of milk

Milk has been part of the human diet for millennia and is valued as a natural and traditional food. Milk and dairy foods are considered to be one of the main food groups important in a healthy balanced diet, as milk provides a substantial number of vitamins and minerals in relation to its energy content, it is considered a nutrient dense food (Gregory and Lowe, 2000).
Cows’ milk provides a wide range of essential nutrients to the diet. Whilst milk as a source of calcium is often recognized, it is perhaps less commonly known that milk and milk products are also an important source of good quality protein, the B vitamins, B2 (riboflavin) and B12, and the minerals iodine, potassium and phosphorus (Marshall et al., 2005).

Milk consumption has been called a marker for an overall healthy diet because of its association with increased nutrient intake. There is some data to show that nutrient intake is enhanced when dietary patterns include milk and dairy product (Marshall et al., 2005).

Milk and dairy are major contributors to calcium, riboflavin (vitamin B2), and phosphorus and iodine intake in the diet. For young children they also contribute significantly to protein, vitamin A, potassium, magnesium and zinc intake. In countries such as the US where milk is fortified, dairy foods can make an important contribution to vitamin D intake (Gregory and Lowe, 2000).

### 2.1.3 Composition of milk

#### 2.1.3.1 Water

For all animals, water is the nutrient required in the highest quantity, and milk contains a lot of water (88.6%). This amount of water is controlled by amount of lactose (Adams et al., 2007).

#### 2.1.3.2 Protein

Milk is a good source of high quality protein. Milk and milk products are the largest source of protein and the second largest contributor further to meat and meat products in all other age.

Cows’ milk contains about 3.5% protein by weight, and of this total protein, 80% is casein and 20% whey. Casein is the dominant protein in milk and can be fractionated into four major components: alpha, beta, gamma and kappa-casein. Whey protein is composed predominantly of beta-lacto globulin and alpha-lacto albumin, but other whey proteins include serum albumin, immunoglobulin's (IgA, IgG, IgM), protease peptones, lactoferrin and transferrin. (Henderson et al. 2003).
2.1.3.3 Carbohydrate

The principal carbohydrate found in milk is lactose. Cow's milk contains about 4.5g lactose per 100g milk and there is some evidence that lactose is the least cryogenic of the common dietary sugars. In addition, various other components of milk have been considered to be protective against dental caries (Miller et al., 2007).

2.1.3.4 Fat

The fat content of milk varies depending on whether milk is whole, semi-skimmed or skimmed. Whole milk contains only around 3.5% fat (3.5g/100g). Semi skimmed milk contains 1.7% fat (1.6g/100g or 1.7g/100ml). Skimmed milk contains only 0.1% fat (0.1g/100g or 0.1g/100ml). Since January 2008 1% milk, which as the name implies contains 1% fat (Henderson et al., 2003).

Milk fat contributes unique characteristics to the appearance, texture, flavor and stability of dairy foods. Dairy fat is a source of energy, essential fatty acids, fat-soluble vitamins, and several other components, such as conjugated linoleic acid (CLA) and sphingolipids.

About a quarter of the fat in milk is monounsaturated. The remainder is mostly saturated fat, although some polyunsaturated fats and other minor fatty acids are also present. (Henderson et al., 2003).

Palmitic, stearic and myristic acids are the major saturated fatty acids found in milk. Dairy fat is also comparatively rich in the short and medium chain saturated fats. Research continues to unravel the complexities associated with individual fatty acids and fats from different sources and it is becoming increasingly apparent that not all fatty acids, or saturated fatty acids, have the same biological effects. There are a variety of saturated fatty acids in milk and many of these have no effect on plasma cholesterol (Henderson et al., 2003).

2.1.3.5 Whey protein

Other milk proteins are present in the whey serum and whey proteins are defined as soluble proteins in the whey after precipitation of caseins at pH 4.6 and at 20°C. Serum proteins include a first protein fraction (80%) consisted of β-lactoglobulin (β-LG), β-lactalbumin (LA Da), bovine serum albumin (BSA) and immunoglobulin a.
second non-protein fraction (20%) is composed of proteose, peptone and nitrogen compound (De Wit, 1981).

### 2.1.3.6 Vitamins and minerals

Milk is a good source of the B vitamins, riboflavin or B2 and B12. Significant amounts of riboflavin are present in milk. Riboflavin is necessary for the release of energy from foods and the health of the body's membranes including the skin. It is also crucial for the maintenance of normal vision, normal red blood cells and functioning of the immune system. Riboflavin further contributes to the protection of DNA, proteins and lipids from oxidative damage. Milk and milk products are the main sources of riboflavin in pre-school children's diets and the diets of school children and adolescents (4-18 years), adults (19-64 years), and the elderly (65 years and over). A 200ml glass of semi-skimmed milk provides 45% of an adult (19-50 years) daily requirement for riboflavin (Keast *et al*, 2010).

Vitamin B12 is required for the maintenance of healthy nerves and red blood cells, as well as normal energy production and cell division. It is also needed for normal function of the immune system, neurological and psychological function, and reduction of tiredness and fatigue. Milk products are the main sources of B12 in the diets (Keast *et al*, 2010).

![Figure 2.1: Vitamins content of cow milk and treated milk.](image_url)
Minerals play an important role in the structural organization of casein micelles, the main minerals present in milk. The major salt constituents, potassium, sodium, calcium, magnesium etc., are distinguished if the content is greater than 0.1 g per liter of those containing trace amounts (Amiot et al, 2002).

2.1.3.7 Calcium

Milk is an excellent source of calcium which, as commonly recognized, is essential for the healthy growth and maintenance of teeth and bones. Calcium is also important for normal blood coagulation, normal energy yielding metabolism, normal muscle and nerve function, normal digestive function and normal regulation of cell division and differentiation.

Milk and milk products are the main sources of calcium in pre-school school children and adolescents (4-18 years), adults (19-64 years) and the elderly (65 years and over). A 200ml glass of semi-skimmed milk can provide a 6-year-old child with over half (55%) of his or her calcium requirement and can provide an adult (19-64 years) with over a third (35%) of his or her daily calcium requirements (Murphy et al, 2008).

2.1.3.8 Iodine

Milk is also a good source of the mineral iodine. Iodine is required for the production of the thyroid hormones and normal thyroid function, for normal energy yielding metabolism and contributes to the maintenance of normal skin. The main sources of iodine in the UK diet come from milk and dairy products in all age groups from preschool children to the elderly. A glass (200ml) of semi-skimmed milk will provide a child of 6 years with 96% of their daily requirement for iodine and an adult (19-50 years) with 44%, but there is some seasonal variation in the iodine content of milk (Weaver, 2010).

2.1.3.9 Phosphorus

Phosphorus plays a vital role in the maintenance of healthy bones and teeth, as well as cell membrane structure and regulation of the body's rate of energy metabolism.
The main sources of phosphorus in the UK diet come from milk and milk products throughout all age groups. A 200ml glass of semi skimmed milk will provide a child of 6 years with 55% of their daily requirement for phosphorus and an adult (19-50 years) with 36% (Murphy et al, 2008).

### 2.1.3.10 Potassium

Potassium is important for helping to maintain normal blood pressure and helps maintain muscular and neurological function. Milk and milk products are the main sources of potassium in the UK diets of pre-school children and the elderly (65 years and over), and the second largest contributor, after potatoes, in the diets of school children and adolescents (4-18 years). A 200ml glass of semi skimmed milk will provide a child of 6 years with 29% of their daily requirement for potassium and an adult (19-50 years) with 9% (Keast et al, 2010).

### 2.1.4 Fermented Milk Products

The introduction of fermented milk products such as cheeses and yogurts in to the diet of man is thought to date back to the dawn of the civilization (Mckinley, 2005). Consumption of fermented-milk products is associated with several types of human health benefits partly because of their content of lactic acid bacteria. Several experimental observations have indicated a potential effect of lactic acid bacteria (LAB) against the development of colon tumors (Wollowski et al. 2001). Recently, the role of fermented milks containing lactic acid bacteria (LAB), such as Lactobacillus, Bifidobacterium and Streptococcus thermophilus, has been studied (Saikali et al. 2004).

A wide range of other health benefits, including improved lactose digestion, diarrhea prevention, immune system modulation and serum cholesterol reduction, have been ascribed to fermented milk consumption.

### 2.1.4.1 Kephir (kefir)

Kephir is a viscous, highly acidic beverage produced from cow, goat, sheep or mare milks which can contain various amounts of alcohol and carbon dioxide. Kephir has both therapeutic attributes and nutritional attributes, such as high contents...
of thiamine, riboflavin, pantothenic acid and vitamin C (the vitamin content varying with milk source and supplementary flora), protein and minerals. Kephir also contains greater amounts of threonine, serine, alanine and lysine than does milk (Ribeiro and Ribeiro, 2010)

2.1.4.2 Kumys (kumis)

This fermented product, generally made from equine or goat milk, is consumed in Russia and western Asia primarily for its therapeutic value. Equine milk cannot be used to produce cheese as no curd is formed on addition of rennet. However, it forms a weak coagulum under acidic conditions and this is exploited in the production of yoghurt-type products such as kumys (Uniacke-Lowe et al, 2010).

2.1.4.3 Tarag

This traditional naturally-fermented goat milk from China forms part of the staple diet of the Mongolian community, who reportedly consume 1–2 liters of tarag per person per day (Zhang et al, 2009).

2.1.4.4 Dahi (dadhi)

According to some estimates, about 7 percent of all milk produced in India is used to prepare the traditional fermented milk product dahi (curd, which is equivalent to yoghurt), intended for direct consumption. This is significant, considering that India is now the largest milk producing country in the world. Although dahi is an age-old indigenous fermented milk product, it has managed to retain its popularity and remain part of the Indian diet despite changing lifestyles and food habits. Dahi is reported to be very nutritious, and possess various therapeutic properties; the protein quality of dahi is reported to be higher than that of milk. (Sarkar, 2007)

2.1.4.5 Cheese

Cheese is a vital fermented dairy product which had a major role in human nutrition for centuries. It is an excellent tasty, 99% digestible energy food, which is suitable for all age groups and contains high quality proteins (Chandan and Kilara, 2013).
2.1.4.6 Yogurt

A fermented milk food, yoghurt is produced by lowering the pH of milk proteins to their isoelectric points (about pH 4.6) by the fermentation of lactose to lactic acid using starter bacteria. Yoghurts can be differentiated according to the fat content of the milk used to produce the yoghurt (non-fat, low-fat or whole milk), the milk source (e.g. cow, buffalo, goat or sheep milks the milk used for yoghurt production varies, including milk concentrated by evaporation or filtration, by supplementing milk with milk powders or by reconstituting milk powders directly to the desired concentration (Tamime and Robinson, 1999).

Industrially, yogurts can be largely divided into two types. A set-style yogurt is made in retail containers giving a continuous undisturbed gel structure in the final product (Tamime and Robinson, 1999). On the other hand, stirred yogurt has a delicate protein gel structure that develops during fermentation (Benezech and Maingonnat, 1994). In stirred yogurt manufacture, the gel is disrupted by stirring before mixing with fruit and then it is packaged. Stirred yogurts should have a smooth and viscous texture (Tamime and Robinson, 1999).

2.1.4.6.1 Nutritional Profile of Yogurt

Yogurt is a highly nutritious and easily digestible dairy product which is a rich source of more than ten essential nutrients in particular, certain minerals and vitamins. The nutritional composition of yogurt can be varied according to the strains of starter culture used in the fermentation, type of milk used (whole, semi or skimmed milk), species that milk is obtained (bovine, goat, sheep), type of milk solids, solid non-fat, sweeteners and fruits added before fermentation as well as the length of the fermentation process. However, the general composition of yogurt is more or less similar to that of milk. Therefore, yogurt is a rich source of milk proteins, carbohydrate, minerals such as calcium and phosphorous, and vitamins such as riboflavin (B2), thiamin (B1), cobalamin (B12), folate (B9), niacin (B3) and vitamin A. (Allgeyer et al, 2010).
2.1.4.6.2 Production and Consumption

According to the United States Department of Agriculture (USDA), National Agricultural Statistics Service (2008), a total of 1.63 billion lbs. of yogurt were produced in the United States in 1998, and by 2008, production had increased 120% to 3.59 billion lbs annually. In 2009, production of yogurt totaled a record high 3.83 billion lbs and it was the 12th straight year that yogurt production set a new record. According to Yogurt was one of the 6 traditional snack categories that showed economic growth in 2009, (Lempert, 2009).

2.1.4.6.3 Types of yogurt

Yogurts can be divided into a number of types based on the fact that how they are made. Only some of the most popular types of yogurt available in the market are described in this section.

2.1.4.6.3.1 Balkan-style Yogurt (set-style yogurt)

Balkan-style yogurt is also known as set-style yogurt which has a characteristic thick texture and made in small and individual batches after poured the warm cultured mix into containers following by incubation without any stirring for over 12 hours or more until the desired thickness and creaminess is attained (Dairy Goodness, 2013).

2.1.4.6.3.2 Greek-style Yogurt

This is also known as Mediterranean-style yogurt made of either from partially condensed milk or by staining whey from plain yogurt to make it thicker and creamier. Due to its thick texture, it tends to hold up better upon heat than regular yogurt and thus utilizes as a main ingredient in making thick dips, it claimed to have a high amount of fat including high content of saturated fat. However, it is likely to be a rich source of vitamin A as a 150g of serving will provide one fifth of the Recommended Daily Allowance of vitamin A. (Dowden, 2013).
Greek-style yogurts are available, in full fat and low-fat versions, many cooks and bakers used to make their own strained yogurts with the intension to utilize in their cuisines in fresh form (Dowden, 2013).

2.1.4.6.3.3 European-style Yogurt/Stirred Curd Yogurt

European-style yogurt is a type of stirred yogurt with a characteristic creamy and smooth texture and is made by incubating the yogurt mixture in a large vat instead of individual cups, followed by cooling and then stirring in order to obtain a creamy texture most often with added fruits (blueberries, strawberries, mango, and peach) and flavors. Yogurts of this style are slightly thinner than that of the Balkan-style and set yoghurt and can be incorporated into cold beverages and desserts (Mckinley, 2005).

2.1.4.6.3.4 Fruit Yogurt

There are two kinds of fruit yogurts: one has the fruits set at the bottom of the packaging (sundae-style yogurt) while the other has the fruit uniformly distributed within the yogurt itself (Swiss style yogurt). Fruit pieces or pulp are added at production stage that produces variety of tastes while increasing consumer appeal and sweetness (Daily Australia, 2013).

2.1.4.6.4 General manufacturing procedure of yogurt

2.1.4.6.4.1 Ingredients for yogurt manufacture

Yogurt is made with a variety of ingredients including milk, sweeteners, stabilizers, fruits, flavors, and bacterial cultures. Milk is the main ingredient used in yogurt manufacturing the type of milk to be used depends on the variety or type of the yogurt that will be prepared.

Stabilizers are usually added to the mix in order to increase the body and texture leading to an increase in firmness, prevents whey separation. (Tamime, 1999).

2.1.4.6.4.2 Homogenization
Homogenization treatment reduces the diameter of fat globules to less than 1µm and ensures uniform distribution throughout the food matrix, thus considered as an important processing step especially for yogurt with high fat content. Consequently, it results no distinct creamy layer on surface of the yogurt and improves consistency of the yogurt (Chandan, 2013).

Homogenization is accomplished by using a homogenizer or viscolizer where the milk is forced through small openings at a high pressure in which the fat globules are broken up due to the shearing forces (Dairy Consultant, 2013).

2.1.4.6.4.3 Heat Treatment

It is generally considered that the heat treatment of milk is an essential step in yogurt manufacturing process that greatly influences the microstructure and physical properties of yogurt. Heat treatment has a number of beneficial effects as it will destroy the microorganisms present in milk or yogurt mixture which can potentially interfere with the controlled fermentation process (Serra et al., 2009).

The time-temperature combinations for the batch heat treatments that are commonly employed in the commercial yogurt making include 85 º for 30 min and 90-95 ºC for 5 min, Heat treatment of milk is important to destroy unnecessary pathogenic organisms and enzymes present in milk (Serra et al., 2008).

2.1.4.6.4.4 Inoculation and Fermentation

After the heat treatment, the yoghurt mixture is cooled to 43-46 ºC prior to the addition of yogurt starter culture bacteria at a concentration of about 2 % (v/v). This temperature range is optimal for the thermophilic microorganisms used in the yogurt starter culture the typical standard yogurt culture consists of S. thermophilus and L. delbrueckii subsp. bulgaricus in 1:1 ratio (Dairy Consultant, 2013).

Incubation temperature is maintained and monitored at optimal level throughout the fermentation process for few hours (2.5-3 h) until the pH and acidity reached their desired levels prior to discontinue the fermentation process by rapid cooling. During the fermentation process, due to the metabolic activity of the lactic acid bacteria used, lactose converts into lactic acid which coagulates milk proteins along
with the production of certain volatile compounds that gives its characteristic flavor and aroma. (Dairy Consultant, 2013).

2.1.4.6.4.5 Cooling

When yogurt has reached the desired pH (4.5-4.6), it will then often blast chilled to refrigerated temperatures (<10 ºC) in order to stop the fermentation process and thereby stops further acid development in the manufacture of set-yogurt, yogurts are directly transferred to a cold store or blast chilled in cooling tunnels. On the other hand, in the manufacture of stirred-yogurt, cooling is first performed by agitating the coagulum in the jacketed fermentation vat in order to produce smoothened product before filling to containers (Lee & Lucey, 2010).

According to the USDA Specifications, after the final steps in manufacturing and/or packaging, the yogurt should be cooled and maintained at temperatures less than 7.2ºC (USDA, 2001).
Standardization of milk

Homogenization 55-65 ºC and 15-20/5 MPa

Pasteurization

80-85 ºC for 30 min or 90-95 ºC for 5 min

Cooling to incubation temperature (43-45 ºC)

Inoculation of starter culture (2% v/v)

Packing into individual containers

Fermentation/Incubation (42-45 ºC)

Fermentation/Incubation (42-45 ºC)

Cooling and cold storage (< 4 ºC)

Stirring

Set-yogurt

Cooling, Pumping and Packaging

Cooling, Storage (<4 ºC)

Stirred-yogurt

Figure 2.2: Manufacturing process of set- and stirred-yogurt (Adapted from Lee and Lucey, 2010).
2.2 Rice

2.2.1 Origin of rice

*Oryza Sativa*, it is believed, is associated with wet, humid climate, though it is not a tropical plant. It is probably a descendant of wild grass that was most likely cultivated in the foothills of the far Eastern Himalayas, it is believed that the rice plant may have originated in southern India, then spread to the north of the country and then onwards to China. It then arrived in Korea, the Philippines and then Japan and Indonesia. Arab travelers took it to Egypt, Morocco and Spain and that is how it travelled all across Europe (Yang *et al*, 2013)

Rice is one of the most important food crops of India. Major share of rice is cultivated during autumn season. A small share of rice is grown in rabi/summer season with assured irrigation (Laurey, 1999).

2.2.2 Importance of Rice

- Rice is an important staple food crop for more than 60 per cent of the world people. In 2008, more than 430 million metric tons of rice were consumed worldwide, according to the USDA.(Chung, 2006)
- Ready to eat products popped and puffed rice, instant or rice flakes, canned rice and fermented products are produced (Chung, 2006).
- Rice straw is used as cattle feed, used for thatching roof and in cottage industry for preparation of hats, mats, ropes, sound absorbing, straw board and used as litter material. Rice husk is used as animal feed, for paper making and as fuel source (Abdul-Hamid and Luan, 2000)
- Rice bran is used in cattle and poultry feed, defatted bran, which is rich in protein, can be used in the preparation of biscuits and as cattle feed. Rice bran oil is used in soap industry. Refined oil can be used as a cooling medium like cotton seed oil / corn oil. Rice bran wax, a byproduct of rice bran oil is used in industries.(Chung, 2006).

2.2.3 Scientific Name

Rice, (*Oryza sativa*) (*2n = 24*) belonging to the family *Gramineae* and subfamily *Oryzoides* (Laurey, 1999).
2.2.4 Nutritional value of Rice

Rice remains a staple food for the majority of the world's population. Rice is very nutritious. This important carbohydrate is the staple food for more than two-thirds of the world's population who rely on the nutritional benefits of rice. Rice has the following nutritional benefits:

- **Excellent source of carbohydrates:** Rice is a great source of complex carbohydrates, which is an important source of the fuel our bodies need.

- **Good energy source:** Carbohydrates are broken down to glucose, most of which is used as energy for exercise and as essential fuel for the brain.

- **Low fat, Low salt, no cholesterol:** Rice is healthful because it does not contain fat, no cholesterol and is sodium free. Rice is an excellent food to include in a balanced diet.

- **No Gluten and Low Sugar Rice** is gluten free. All rice is gluten free, making rice the essential choice for people with gluten free dietary requirements.

- **Contains Resistant Starch:** Rice also contains resistant starch, which is the starch that reaches the bowel undigested. This encourages the growth of beneficial bacteria, keeping the bowel healthy. (M. Umadevi *et al.*, 2012)

2.2.5 Chemical Nutrient Composition of Rice

The rice grain consists of 75-80 % starch, 12 % water and only 7 % protein with a full complement of amino acids. Its protein is highly digestible with excellent biological value and protein efficiency ratio owing to the presence of higher concentration (~ 4 %) of lysine (FAO and WHO, 1998).

Minerals like calcium, magnesium and phosphorus are present along with some traces of iron, copper, zinc and manganese (M. Yousaf, 1992)

In addition to being a rich source of dietary energy, rice is a good source of thiamine, riboflavin and niacin. Although the nutritional values of rice vary with different varieties, soil fertility, fertilizer application and other environmental conditions, rice grains contain about 80 % carbohydrates which include starch, glucose, sucrose, dextrin, etc. Varieties of rice with high protein and vitamin (vitamin A) content have been obtained through genetic engineering (M. Yousaf, 1992).
2.2.6 Medicinal Uses of Rice

Skin Inflammation Rice may also be used externally in the form of powder. The rice flour, dusted thickly over the surface, has a very cooling and soothing effect in small-pox, measles, prickly heat and other inflammatory affections of the skin including burns and scalds. It allays heat and irritation. Rice powder should be used soon after the occurrence of injury in case of burns and scalds and it should be dusted thickly over the whole of the affected surface (Umadevi et al., 2012).

High Blood Pressure Rice has a low-fat, low-cholesterol, low-salt contents. It makes a perfect diet for those hypertension persons who have been advised salt-restricted diets. Calcium in white rice, in particular, soothes and relaxes the nervous system and helps relieve the symptoms of high blood pressure. (M. Umadevi et al., 2012).

Cancer Prevention and Diet: Whole grains (such as brown rice) contain high amounts of insoluble fiber - the type of fiber some scientists believe may help protect against a variety of cancers.

Diarrhea in Children: Rice is useful in treating diarrhea in children. A teaspoonful of powder of charred parboiled rice mixed with a glassful of butter-milk should be given in doses of an ounce every half an hour in this condition. This will bring excellent results. (M. Umadevi et al., 2012)

Alzheimer’s disease: Brown rice is containing high levels of neurotransmitter nutrients that can prevent Alzheimer’s disease to a considerable extent. (M. Umadevi et al., 2012).

Heart Disease: Rice bran oil has an antioxidant property that promotes cardiovascular strength by reducing cholesterol levels in the body. (M. Umadevi et al., 2012).

More on Rice: can also prevent chronic constipation. The insoluble fiber from rice acts like a soft sponge that may be pushed through intestinal tract quickly and easily (M. Umadevi et al., 2012).
CHAPTER THREE
MATERIALS AND METHODS

3.1 Materials

All the glassware media and other materials used were either wet sterilized or dry sterilized. The dry sterilization was done by oven at 160°C for 2 hours, while wet sterilization was carried out in autoclave at 121°C for 15 minutes. The media were prepared according to the manufacturer's instructions.

3.1.1 Fresh Milk

Fresh whole cow milk was obtained from the Wad Almagdob farm. Milk was immediately cooled and transported to the factory in the Wad Almagdob, Gezira State, Sudan.

3.1.2 Fresh Rice Flour

Fresh rice was collected from a local market in Wad Medani city, Gezira State, Sudan, and then it will be transported to the factory in Wad Elmagdob, Gezira State, Sudan.

3.2 Methods

3.2.1 Preparation of rice flour

Rice was first choice of rice quantity then rice is cleaned of dirt and then washed with water to get rid of dust and then soaked in water for three hours and filtered rice from the water and placed in the sun and then milled to a fine flour which was kept in a closed for further use (Mukprasirt et al, 2000).

3.2.2 Processing of yogurt

Five liters were taken for each sample in stainless steel container and heated to 85°C for 30 minute. After pasteurization the milk was cooled to 44.6°C, starter culture in ratio 1.5% was added to milk at 44.6°C. Two types of yogurt were prepared, the first type was left free without any additive of rice flour, the second type was addition rice flour at the levels of 2, 4, and 6 % to the milk respectively, after addition the starter culture to the milk, poured the milk in container sealed then put in the incubator about three hour to help to fermentation process after incubation transfer the immediately to refrigerators 4°C.
3.3. Microbiological Analysis

3.3.1. Preparation of serial dilution

Ten-gram samples of yoghurt type were dissolved with 90 ml of distilled water by shaking for several minutes, from this suspension; 1 ml was taken from the dilution and transferred to another tube to make serial dilution up to $10^{-6}$.

3.3.2 Total bacterial count

The total viable count per ml of sample was obtained by pour-plating suitable in triplicates on plate Count Ager (Oxoid) following the method of APHA (1967). Incubation was accomplished at 37°C for 48 hours. Plates containing between 30-300 Colonies were counted as colony forming units (C.F.U) per ml of the sample.

3.3.3 Yeast and mould count

Yeast and mould were enumerated according to Marshall (1993) using potato Dextrose Ager (PDA). The plates were incubated at 25°C for 3-5 days, plates containing between 30-300 colonies were counted as colony forming units (C.F.U/ml).

3.3.4 Coliform bacterial count

Coliform bacterial count was determined according to Marshal, (1992) using Mac Conkey broth. The tubes were incubated at 37°C for 48 hours. Positive tubes gave gas in Durham tubes. Then the positive tubes were sub cultured into EC broth medium and then incubated at 44°C for 24 hours to determine the coliform bacteria, the tube showing any amount of gas production were considered positive.

3.3.5 Salmonella count

100 ml of samples were incubated at 37°C for 24 hours. Then 10 ml were drawn aseptically and added to 100 ml Selenited Broth. The broth was incubated at 37°C for 24 hours then with a loopful streaking was done on dried Bismuth Sulphite agar plates. The plates were then incubated at 37°C for 72 hours. Black metallic sheen discrete colonies indicated the presence of Salmonella. A confirmatory test was carried out by taking a discrete black.
3.4. Chemical analyses

3.4.1 Moisture content

The moisture content was determined by oven method as described by AOAC (2005). In this process, 5g of the sample were dried in a hot air oven for 2 h at 100 °C. The loss in weight was determined and recorded as the moisture content and expressed as;

\[
\% \text{ moisture} = \frac{W_1 - W_2}{W_1} \times 100
\]

Where;
W₁ = Initial weight of the sample; W₂ = Weight of the dried sample

3.4.2 pH Measurement

The pH was determined by the method described by (AOAC, 1980), where 10g of the sample was dissolved in 100ml of distilled water. The mixture was allowed to equilibrate for 3 minutes at room temperature. The pH was then determined by inserting the electrode of the pH meter in the sample then taking the result displayed on the pH meter.

3.4.3 Determination of Total Titratable Acidity (TTA)

This was determined by the method described by AOAC (2005). The sample was dissolved in distilled water and mixed thoroughly. 1ml of phenolphthalein indicator was introduced into 10ml of the mixed solution. It was titrated against standard sodium hydroxide solution until pink color persisted for about 10-15 seconds for complete neutralization.

Acidity (lactic acid %) = Titre \times 0.1

Where:
0.1 N of NaOH
3.4.4 Protein Content

The Kjeldahl method was used to determine the amount of nitrogen of the different samples according to AOAC, (1980), then multiplied by a factor of 6.25. The method was composed of three major steps.

1- The Digestion

A portion of the prepared sample was weighed out. It contained about 0.05g protein-to the nearest 1mg, and transferred to a Kjeldahl tube. A glass pearl, 20ml H₂SO₄ and 1:2g catalyst (15g KSO₄ + 1ml CuSO₄) were added. The digestion was carried out in a destruction block until a bright green color appeared, then allowed to cool and 10 ml distilled water were added.

2- The distillation

The tube was placed in the distillation equipment and 30 ml NaOH/thiosulphate solution was added. The ammonia was distilled into 20 ml boric acid indicator solution.

3- The Titration

Then titrated with 0.05 N HCl

The protein content was then calculated as follows:

\[
\text{Nitrogen} \% = \frac{V \times T \times 14 \times \text{Volume of diluents digest}}{100 \times G} 
\]

Where:

\[V: \text{ number of ml of the HCL solution.}\]
\[T: \text{ normality of HCl.}\]
\[G: \text{ weight (g) of the sample.}\]

3.4.5 Ash Content Determination

The ash content was determined by the direct heating method as contain in AOAC, (2005). In this method, 5g each of the samples was measured into a crucible of known weight, the sample was burnt to ash in a muffle furnace for 3h at 500C. It was then cooled in a desiccators and the weight of the ash was finally determined.
The % Ash content was calculated as:

\[
\text{Ash} (\%) = \frac{W_1 - W_2 \times 100}{W_1}
\]

Where:

\( W_1 \) = Initial weight of the sample.
\( W_2 \) = Weight of the dried sample.

### 3.4.6 Fat content determination

The fat content was determined by Gerber method according to AOAC, (2003) as follows: 10g of yoghurt sample was taken, 10 ml sulfuric acid and 1 ml of amyl alcohol was added to it and close with rubber cork. And centrifuged at 1100 revaluations per minute (rpm) for 15 minutes and the tubes were then transferred to a bath at 65°C for 5 minutes. The fat percent was then read out directly from the fat column.

### 3.4.7 Determination of mineral content

The content of minerals of yogurt was determined according to the methods described by (AOAC, 1990). Samples were weighed into porcelain crucibles and ashed in a muffle furnace at a temperature of 500°C for 6 hours. After ashing the products were cooled in a desiccator. The ashes were then dissolved into an acidic aqueous solution (concentrated HNO₃) for their analyses. Each product was then transferred quantitatively to 250 ml volumetric flask and distilled water was added to fill the flask and was shaken many times. Then the aqueous sample was diluted with strontium solution two times.

The flame atomic absorption spectrophotometer (FAAS) with variant spectrometer (spetr AA-10) was used to determine the macro– elements and the micro–elements. Flame photometer (Model Eppendorf Elex 6361) was used to determine phosphorous. The necessary equipment adjustments were accomplished. Calibration was accomplished using six standards ranging from 0.1µ/ml magnesium, 0.25 µ/ml sodium and potassium to a top standard with 2.0µ/ml magnesium, 5.0µ/ml sodium and potassium. Calcium analyses were performed with the use of 4% hydroxyquinone.
3.5 Physical analysis

3.5.1 Viscosity

The viscosity of the samples was determined by the method of as contained in Jeremia and Afam, (2013). The spindle of the viscometer was inserted into the samples at the speed of 20rpm and the reading on the viscometer was taken after 3 minutes for each sample.

3.5.2 Serum Separation

Serum Separation samples were placed in 20 ml graduated cylinders. After storage at 4°C, the volume of the layer of clear serum at the top was recorded as an indication of instability. Measurements taken performed in duplicate (Koksoy and Kilic, 2003).

3.5.3 Dry matter

Dry matter was determined according to gravimetric method AOAC (1990). Heating 5 ml sample in oven at 100°C for 3 hrs. Dry matter were calculated by formula:

\[
\text{Dry matter} \% = \frac{\text{Weight of residue after drying}}{\text{Weight of sample}} \times 100
\]

3.5.4 Lactose

The procedure of (AOAC, 1980) was used for determination of lactose

**First:** The invert sugar was determined by pipette 5ml from each Fehling A+B in a conical flask and 10 ml of distilled water was added.

Then 3-5 drops of methylene blue was added as an indicator. Then the lactose standard was titrated until the final red precipitate occurred. Then the Fehling factor was calculated from the following equation.

**Fehling factor:** The titration \( \times \) the concentration after that the lactose was determined by prepared 10 ml of yoghurt in 100 ml volumetric flask. Then the volume was completed to 100 ml by adding distilled water.

Then mixture was filtered. Finally the sample was titrated against Fehling solution (A+B) as before. Then the
concentration of lactose was calculated from the following equation:

\[
\text{Lactose \%} = \frac{\text{Fehling factor} \times 100}{\text{Concentration} \times \text{titration}}
\]

3.6 Chemical analyses of raw milk

The various chemical analysis which included moisture, total solids, fat, protein, lactose, ash, titratable acidity and pH of raw milk were determined by using Milkana instrumental.

3.7 Sensory evaluation

Yogurt samples were subjected to sensory evaluation using (10) panelists, the panelists were asked to assess each sample for color, appearance, flavor, texture and overall acceptability a 9-point hedonic scale with 1 as the extremely bad and 9 the excellent. All analysis took place in a room free from disturbing noises, and in which fresh air was circulation conditions were equalized for all the tests. The order of presentation for samples was randomized and the samples were given codes before being tested.

3.8 Statistical analysis

Statistical analysis was done using Statistical Package for Social Studies Software SPSS, (1988). Complete Randomized Design was used to estimate chemical, microbiological and sensory characteristics of the yogurt.
CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Chemical composition of milk sample used for production of yogurt with rice flour

The chemical composition of raw milk sample used for production of yogurt is presented in Table 4.1. The moisture content of raw milk 85% was lower when compared to Salma et al (2016) which was 87.31%. The moisture content value was in close agreement with the moisture content of raw cow's milk as reported by Sohail, (1983) which was 85%

The total solids (T.S) content of raw milk was 11.98% similar values were reported by A. Enb et al., (2009) which was 12.10%. This result was in with those agreement reported by Abdul Kader et al, (2015) which was 11.70%.

Fat content of raw milk 3.72% was higher when compared to the milk sample of A. Enb et al., (2009) which was 3.20%. The fat content of raw milk was in close agreement with that reported by Abdul Kader et al, (2015), who found fat content of 3.70 %.

The protein content of raw milk 3.39% was lower when compared with Saha (2012) which was 4.14%. The protein content values were in close agreement to the protein content of raw milk as reported by Abdul Kader et al, (2015) which was 3.38%.

The lactose content was 4.92% was lower when compared with A. Enb et al., (2009) which was 5.0%.

Table 4.1 also, shows of that the ash content raw milk 2.89. This result agreed with that of Salma et al (2016) who reported a value of 2.88%. The ash content of raw milk was higher compared to A. Enb et al., (2009) which was 0.65

The titratable acidity of raw milk 0.16 % was close agreement to the titratable acidity reported by A. Enb et al (2009) which was 0.17%.
The data presented in Table 4.1 also showed that the pH value of raw milk 6.70% this value was in close agreement to that reported by Salma et al. (2016) who found a pH value of 6.71 in raw milk and also with A. Enb et al., (2009) which was 6.60.

Table 4.1: Chemical composition of raw milk sample

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Raw milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>83.00±0.04</td>
</tr>
<tr>
<td>Total Solid (%)</td>
<td>11.98±0.03</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>3.72±0.06</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.39±0.09</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td>4.92±0.3</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>2.89±0.01</td>
</tr>
<tr>
<td>Acidity</td>
<td>0.16±0.07</td>
</tr>
<tr>
<td>pH value</td>
<td>6.70±0.03</td>
</tr>
</tbody>
</table>
4.2. Chemical composition of processed yogurt by added rice flour

The chemical composition of processed yogurt by added rice flour with different concentrations of rice flour (2, 4 and 6% g/l) is shown in Table 4.2.

The value of moisture content in control was (86.86%) this value higher than other found in yogurt with 2,4,6% rice flour which were 86,85.56,85.58%, respectively. Statistically, significant differences (p<0.005) in moisture content of different concentrations of rice flour in yogurt samples were found. These results were of similar value reported by Kavas Nazan, (2016), which was 85.46%. Because the addition of rice flour decreases the moisture content in yogurt.

The protein content of yogurt sample was 4.16, 4.20, 4.57 and 4.83% in control, 2, 4 and 6%, respectively. Statistically, no significant differences (p<0.005) in protein content of different concentrations of rice flour in yogurt samples were found. The highest protein content was (4.83%) was recorded in yogurt sample produced by 6% while the lowest one in control sample which was (4.16%). This results were higher that reported by Igbabul et al., (2014) which was 3.70%.

The fat content in control sample was 2.19 This value lowest compared to those found in yogurt sample processed by added rice flour in ratio 2,4,6% which were 2.21, 2.21, 2.23%, respectively, no significant differences (p<0.005). These results are lower value as that reported by Ibrahim et al. (2015) which was 4.36

The ash value in control was 0.26% is lower than other yogurt sample processed by different levels of rice flour 2, 4 and 6% which were 0.35, 0.52, 0.72%, respectively. These values were in close agreement to that reported by Ibrahim et al. (2015) which was 0.74 %. Statistically, no significant variation (p< 0.005) between yogurt samples in ash content.

On the other hand, the pH value in Table 4.2, the control sample was 3.73 this value lower than other sample 2, 4, 6% rice flour which was 3.81, 3.92, and 4.17 %, respectively. The results showed significant different as (p>0.005). These results were in close agreement with that reported by Warda et al., (1998), which was 3.60

The data presented in Table 4.2 also, showed that the values of titratable acidity (lactic acid %) was 1.04 in control sample, this value higher than found in yogurt sample processed by different levels of rice flour 2,4 and 6% which were 0.94, 0.82, 0.76%, respectively. These result in line with those found by Kavas Nazan, (2016), which was 0.71.
Table 4.2 chemical composition (%) of processed yoghurt with addition of rice flour.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control sample</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>Moisture%</td>
<td>86.86±0.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>86.00±0.09&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Protein%</td>
<td>4.16±0.12&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.20±0.10&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fat %</td>
<td>2.19±0.08&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.21±0.22&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ash%</td>
<td>0.26±0.16&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.35±0.13&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>pH</td>
<td>3.73±0.23&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.81±0.10&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Titratable acidity</td>
<td>1.04±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.94±0.13&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Mean values ± standard deviation having different superscript letter(s) in each row differs significantly (p<0.005).
4.3. Physical composition of processed yogurt by added rice flour

the Viscosity (cp) value in control was 4212 cps is higher than other yogurt sample processed by different levels of rice flour 2,4,6% which were 3900, 3876,3766 cps, respectively. These values were in close agreement to that reported by Warda, (1998) which was 3,900 cps. Statistically, significant variation \((p< 0.005)\) between yogurt samples in the Viscosity

The data presented in Table (4.3) also, showed that the Serum separation of yogurt sample were 5.32, 4.47, 4,20 and 3.70 ml in control ,2, 4 and 6%, respectively. the lowest Serum separation was 3.70 ml was recorded in yogurt sample produced by 6% of rice flour and while the higher one in control sample which was 5.32ml. These results were lower than reported by Kavas Nazan. (2016) which was 9.83.

Lactose level in control was 4.32% is lower than other yogurt sample processed by different levels of rice flour 2,4,6% which were 4.33, 4.32 and 4.34%, respectively. These values were in close agreement to that reported by Kavas Nazan, (2015) which was 4.43% but higher result compared by warda, (1998), which was 2.70. Statistically, no significant variation \((p< 0.005)\) between yogurt samples in lactose levels.

The data presented in Table 4.3 also, showed that the dry matter of yogurt sample in control which was 13.14) this result lower than other found in yogurt sample with 2,4 and 6% rice flour which were 14.0, 14.44, 15.42% ,respectively. Statistically, significant differences \((p<0.005)\), in dry matter of different concentrations of rice flour in yogurt samples were found. These results in line with those found by Kavas Nazan, (2016), which was 14.54%.
Table 4.3. Physical analysis of processed yoghurt with addition of rice flour.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control sample</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>Viscosity</td>
<td>4.212±0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3,900±0.04&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Serum separation</td>
<td>5.32±0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.47±0.12&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lactose</td>
<td>4.32±0.07&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.33±0.21&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dry matter %</td>
<td>13.14±0.14&lt;sup&gt;c&lt;/sup&gt;</td>
<td>14.00±0.11&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Mean values ± standard deviation having different superscript letter(s) in each row differs significantly ($p<0.005$).
4.4 Minerals content (mg/100g) of processed yogurt by added rice flour.

The mineral contents of control sample and different concentration of processed yogurt by addition rice flour are shown in Table 4.4.

In processed yogurt samples the concentrations of Calcium (ca) in control sample was 128.16 mg/100 g these result lower than found in processed yogurt by added rice flour were 135.0, 136.22, 136.91mg/100g in 2, 4 and 6%, respectively. The highest one was recorded in yogurt sample produced by 6% of rice flour which was 136.91 mg/100g while the lowest one in control sample which was 128.16mg /100 g. These results higher than reported by Ibrahim et al (2015) which was 98.00 mg/100 g. Statistically, significance different (P < 0.005) between yogurt samples in concentrations of calcium.

The data presented in Table 4.4 also, showed that the concentrations of potassium (K) in control sample was 50.67mg/100 g lower than found in processed yogurt by added rice flour were 60.33, 65.33 ,66.00mg/100 g in 2, 4 and 6%, respectively. These results higher than reported by A. Enb et al, (2009) which was 44.5 Statistically, significant different (p<0.005) between yogurt sample in concentrations of potassium.

In processed yogurt sample the concentrations of sodium (Na) the highest one was recorded in yogurt sample produced by 6% of rice flour which was 60.67mg/100 g. and while the lowest one in yogurt sample produced by control of yogurt which was 46.67mg/100 g. These results in line with those found by Ibrahim et al (2015) which was 61.21 Statistically, significant difference (p< 0.005) between yogurt sample in concentrations of Sodium.
Table 4.4. Minerals content (mg/100g) of processed yoghurt by added rice flour.

<table>
<thead>
<tr>
<th>Element</th>
<th>Control sample</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>Calcium(mg/100g)</td>
<td>128.16±0.33\textsuperscript{b}</td>
<td>135.0±0.34\textsuperscript{c}</td>
</tr>
<tr>
<td>Potassium(mg/100g)</td>
<td>50.67±0.19\textsuperscript{c}</td>
<td>60.33±0.49\textsuperscript{b}</td>
</tr>
<tr>
<td>Sodium(mg/100g)</td>
<td>46.67±0.23\textsuperscript{a}</td>
<td>54.66±0.28\textsuperscript{b}</td>
</tr>
</tbody>
</table>

Mean values ± standard deviation having different superscript letter(s) in each row differs significantly ($p<0.005$).
4.5 Microbial load (c.f.u/ml) of yoghurt processed by added different levels of rice flour.

The results obtained from the microbiological analysis of yoghurt samples were shown in Table (4.5). The total bacterial count (TBC) of control sample which was $4.57 \times 10^5$ cfu/ml. while in processed yoghurt by added rice flour which were $6.33 \times 10^4$, $6.70 \times 10^4$, $5.40 \times 10^4$ cfu/ml in 2, 4 and 6%, respectively. The highest total bacterial count was recorded in control sample and while the lowest one in yoghurt sample produced by 6% rice flour. These results were lower than those reported by Eshraga et al., (2011), which was $6.5 \times 10^5$ cfu/ml. statistically, significant different ($P < 0.005$) between yoghurt samples in total bacterial count.

Table 4.5 showed the yeast and moulds count were detected in all yoghurt samples. control sample which was $2.76 \times 10^3$ cfu/ml. while in processed yoghurt by different levels of rice flour which were $1.20 \times 10^2$, $2.50 \times 10^2$, $1.87 \times 10^2$ cfu/ml in 2, 4 and 6%, respectively. the highest yeast and moulds count was recorded in control sample. while the lowest one in yoghurt sample produced by 2% of rice flour. These results in line with those found by Igbabul et al., (2014) which was $2.00 \times 10^2$. Statistical analysis showed that there were significant differences at ($P < 0.005$) in yeasts and moulds.

*Colifrom* bacteria count not detected in control sample and other sample of processed yoghurt by different levels of rice flour. due to good pasteurization of milk, while in previous studies there is growth *Colifrom* bacteria was detected which was $1.7 \times 10^3$ cfu/ml in Eshraga et al (2011).

*Salmonella* count was not detected in all yoghurt samples due to good pasteurization of milk and control condition during processing.
Table 4.5. Microbial load (c. f. u/ml) of yoghurt processed by added different levels of rice flour.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control sample</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td><strong>Total bacteria count</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.57x10^5±0.12^a</td>
<td>6.33x10^4±0.11^d</td>
</tr>
<tr>
<td><strong>Mold and yeast</strong></td>
<td>2.76x10^3±0.13^a</td>
<td>1.20x10^2±0.14^c</td>
</tr>
<tr>
<td><strong>Coliform bacterial count</strong></td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td><strong>Salmonella</strong></td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

Mean values ± standard deviation having different superscript letter(s) in each row differs significantly ($p<0.005$); ND: not detected.
4.6. Sensory Evaluation of processed yoghurt by added different levels of rice flour

Sensory evaluation was conducted to evaluate the color, flavor, taste, texture and overall acceptability of rice yoghurt samples. The highest color score in control sample while the lowest one was recorded in yoghurt sample with 6% rice flour, with significant differences (P>0.005).

The addition of different level of rice flour affected the flavor of yoghurt samples. The highest flavor scores were obtained in yoghurt sample with 4% rice flour and the lowest one in control sample, with significant differences (P>0.005).

Taste of yoghurt samples, the highest score was obtained in 2% rice flour while the lowest one in control sample, with significant differences (P>0.005).

The effect of rice flour on the texture of yoghurt samples. The highest texture score of yoghurt was recorded in 6% rice flour while the lowest one in control sample, with significant differences (P>0.005).

The consumer acceptability means values ranged from 9.80 to 7.60 (Table 4.6). Yoghurt samples with 4% rice flour had the highest overall consumer acceptability score and the lowest one in control sample.
Table 4.6. Effect of addition different levels of rice flour on consumer acceptability (Mean ± SE) of yogurt samples (n = 10).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Color</th>
<th>Flavor</th>
<th>Taste</th>
<th>Texture</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>8.80\textsuperscript{a}</td>
<td>6.50\textsuperscript{b}</td>
<td>6.00\textsuperscript{c}</td>
<td>7.00\textsuperscript{c}</td>
<td>7.60\textsuperscript{c}</td>
</tr>
<tr>
<td>Ri 2 %</td>
<td>7.80\textsuperscript{b}</td>
<td>7.50\textsuperscript{b}</td>
<td>8.20\textsuperscript{a}</td>
<td>7.90\textsuperscript{c}</td>
<td>8.10\textsuperscript{b}</td>
</tr>
<tr>
<td>Ri 4 %</td>
<td>7.70\textsuperscript{b}</td>
<td>8.20\textsuperscript{a}</td>
<td>7.60\textsuperscript{b}</td>
<td>8.10\textsuperscript{b}</td>
<td>9.80\textsuperscript{a}</td>
</tr>
<tr>
<td>Ri 6 %</td>
<td>7.50\textsuperscript{b}</td>
<td>7.20\textsuperscript{b}</td>
<td>7.70\textsuperscript{b}</td>
<td>9.00\textsuperscript{a}</td>
<td>8.30\textsuperscript{b}</td>
</tr>
</tbody>
</table>

Mean values ± standard deviation having different superscript letter(s) in each row differs significantly; Ri: rice flour.
CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

- In present study producing yogurts by addition of rice flour caused an increase in nutrition value and improved texture of yogurt.
- The manufactured yoghurt was analyzed chemically, microbiologically and subjected to sensory analysis.
- Yoghurt samples with 4% rice flour received the highest consumer acceptability scores compared with others.
- The microbiological analysis of yoghurt samples indicated the total count of bacteria, mould and yeast no effected significantly \( (p<0.005) \), and no growth of coliform bacteria and Salmonella count.
- Significant decrease in some physical properties such as serum separation and viscosity with addition rice flour compared to control sample.
5.2 Recommendations

Depend on the results of this research; all the main and specific objectives have been done. However the following recommendations can be suggested.

➢ Selection of suitable rice varieties in producing processed yogurt with rice to obtain high quality.

➢ Cleaning thoroughly all equipment’s of yogurt making and containers before making new yogurt.

➢ Incubate milk at $42^0$C, higher temperature my cause separation and curdling and can destroy the active yogurt culture, while lower temperature stop the growth of pathogenic bacteria.

➢ Understanding more physical properties of processed yogurt by adding rice flour during refrigerated storage.

➢ From the outputs of this research suggest adding 4% rice for yogurt to achieve highest consumer acceptability.
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