ACTA SCIENTIFIC NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 4 Issue 9 September 2020

Research Article

Effect of Using Different Plant Milk as Alternative Milk in Rice Pudding

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Received: July 29, 2020

Published: August 24, 2020

Abstract

The aim of study was to produce healthy rice pudding by replacement of cow milk with plant milk as alternative milk and study their effect on the physicochemical, microbiological and sensory properties. Plant milk was produced from black eyes-bean, chick-peas, white lima-bean, oats, rice, soya-bean, yellow corn and cow milk served as control. Protein ranged between 1.7 to 6.02% and the white lima beans had the highest protein value (6.02%). Rice pudding of cow milk the highest value of ash (0.79%) and the lowest value was yellow corn (0.04). Fat % ranged from 0.20 to 3.32% and rice pudding of cow milk the highest fat% (3.32%). Carbohydrate increased with the grains and rice pudding of rice milk the highest carbohydrate values (68.83%). Viscosity of rice pudding of Rice milk were the highest between rice pudding samples and were the best in organoleptic properties. Data also indicated that as a result of pH and acidity of different prepared milk samples and pudding samples. Microbiological analysis of milk samples and rice pudding from plant milk were determined. Viscosity was higher for the rice pudding (16800Cp/s) with low acidity (0.05%) than other samples. Differences in sensory attributes were associated with different rice pudding from plant milk and cow milk. Rice pudding of chick peas milk obtained the least score (16.50) for body and texture whereas rice pudding of cow milk, rice pudding of oats milk, rice pudding of yellow corn milk and black eyed beans received the highest score (19.50, 19.0, 19.0 and18.83 respectively). Sensorial, rice pudding of yellow corn and rice pudding of rice milk is more acceptability than other treatment after the rice pudding of cow milk control.

Thus we recommend to use the plant milk in rice pudding especially, rice pudding of rice milk and rice pudding of Yellow corn milk to give the consumer a new nutraceutical product with prebiotic substances for milk allergy, sensitivity children and plant people.

Keywords: Plant Milk; Oats; Black Eye Beans; White Lima Beans; Yellow Corn; Soya Beans; Chick Peas; Rice; Cow Milk; Rice Pudding; Physical; Chemical; Microbiological and Sensory Properties

Abbreviation

NFE: Nitrogen Free Extracts; TS: Total Solid; CFU: Colony Forming Units; ppb: Part per Billion; Cp/s: Centipoise/second; p/b: Pound per Bushel (American unit)

Introduction

Milk is rich in nutrients; therefore it helps to improve the nutritional status of the people in general. Today, cow's milk is considered the most important source of bioactive peptides [1], but plant proteins also contain bioactive peptides and their potential is very interesting for future research [2]. Vegetable milk and its products have nutritional benefits for human beings due to their richness in protein, fatty acids and minerals, which are considered to be highly valuable for nutrition [3,4]. The non-dairy beverages are beverages made from extracts of plant materials such as soy, rice, coconut, oats or quinoa. These beverages are commonly used as substitutes of cow's milk. The main medical reason for such a substitution is cow milk protein allergy (CMPA), which is diagnosed when there are allergic reactions to casein or whey protein and is characterized by vomiting, loose stools, fussiness, and a reduced weight gain [5]. The incidence of CMPA is between 2-5% and it is normally present in children under the age of three [6]. For adults, the incidence is

much lower. The symptoms of CMPA are normally confused with those of lactose intolerance. Lactose intolerance is due to deficiencies in intestinal lactase (hypolactasia) and leads to abdominal pain, bloating, and diarrhea induced by lactose. Treatment of lactose intolerance can include lactose-reduced diet and enzyme replacement [7]. Lactose-free cow milk is a good alternative for people with lactose intolerance. However, some lactose-intolerant consumers might change to nondairy plant-based beverages. Interestingly, the main reason for the increased consumption of milk alternatives is that consumers perceive non-dairy beverages as more natural and healthier choices than cow's milk [8]. In many countries, the consumption of milk has decreased in recent years. In contrast, the consumption of non-dairy or plant-based beverages has increased by 19% during the same period [8].

The consumption of cereal and grain milks in the Western world has increased over the last 2 decades as a result of increased health consciousness of consumers, the minim section of off-flavors and the reduction of growth inhibitors. This growth is due to three main factors: (i) nutritional benefits offered by plant-based dairy alternatives, such as to reduce the cholesterol level, to improve cardiovascular health, and diabetes control [9]; (ii) the growing consumer preference for vegan diets; and (iii) increasing cases of lactose intolerance and milk allergies [10,11]. The major issue that is hampering the production of legume-based beverage is the "beany" flavor, associated to endogenous lipoxygenases which oxidize unsaturated fatty acids in oil rich pulses like soy [12] and peanuts (over 20% fat), but should be less pronounced in pulses like peas, lupines' or chickpeas (1.5 to 5% fat). The activity of the lipoxygenases is enhanced by the presence of polyphenols (bitter taste), but is suppressed by processing techniques like soaking, germination and pressure-cooking [13]. Few researches in preparing milk alternates other than soy milk includes peanut milk, rice milk, oat milk, sesame milk, coconut milk, almond milk, hemp milk, hazelnut milk, tiger nut, lupine milk and quinoa milk etc. [14-18]. Maize is the most important cereal crop after wheat, rice and barley in terms of production [19]. Maize is a cheap and readily available food product, is very rich in nutrients and relatively high in methionine and cystine, and low in lysine and tryptophan [20,21].

Oats *(Avena sativa)* contain many natural compounds beneficial to health. These include tocopherols, phenols and phytosterols compounds as well as soluble and insoluble fibers. βglucan a unique soluble fiber, is the most recognized health promoting compound. Of the common cereals (wheat, rye, oats and barley), the largest (seed) amounts of βglucan are found in barley (3-11%) and oats (3-7%), [22]. Oats is one of the best sources of inositol, which is very important for maintaining blood cholesterol level. It also contains very high levels of calcium, potassium, and magnesium, coupled with vitamin B-complex. All these vitamins and minerals are very essential for the nervous system Eating oats regularly helps to keep the blood cholesterol level low, act as anti-depressants reduce stress prevents bowel cancer cure constipation, and help in lowering chances of heart-disease, [23]. Oat milk is made from oat groats (oats that have been cleaned, toasted, and hulled), water, and potentially other grains and beans, such as triticale, barley, brown rice, and soybeans. It has a mild flavor and is slightly sweet. Its consistency is similar to that of 1% or skim milk. Oat milk is low in overall calories, cholesterol, and saturated fat. It is higher in fiber than other milk alternatives, with 2g per cup or sometimes more, depending on whether oat bran has been added. It also contains iron, vitamin E, and folic acid. In addition, it offers 4 g of protein per cup, which is relatively higher than most other non-dairy alternatives. At the same time, naturally occurring sugars give this beverage higher carbohydrate content.

Black eye beans *(Vigna unguiculata)* is the most widely consumed legume in West Africa because of its taste and ease with which it is prepared and incorporated into other food recipes. The beans serve as the largest single contributor to the total protein intake of many rural and urban families in these countries. However, just like soybeans (*Glycine max*), there are various problems associated with the consumption of cowpeas, the most important being the development of flatulence by a large number of the consumers. Despite the above, an increasing number of people use cowpeas to wean their children [24]. Unlike Black eye beans, soymilk is especially popular in the Orient, where it is used extensively for infant feeding as well as food for adults. In the United States, soymilk is used by individuals who are allergic to cow milk protein or who are lactose-intolerant.

The soyabean (*Glycine max*) is a species of legume native to East Asia, widely grown for its edible bean which has numerous uses. For example, soybean products, such as textured vegetable protein (TVP), are ingredients in many meat and dairy substitutes [25]. The beans contain significant amounts of phytic acid, dietary minerals and B vitamins. However, Soy milk is a good source of essential monounsaturated and polyunsaturated fatty acids which are considered good for cardiovascular health. It serves as an inexpensive, refreshing and nutritional beverage to the consumers. Iso flavones appeared to be the functionally active component responsible for the beneficial effects of soybean. Iso flavones are well known for their protective effect against cancer, cardiovascular disease, and osteoporosis [26]. Genistein is the most abundant iso flavone in soybean and is proposed to be the most biologically active [27]. Apart from iso flavones, soy proteins are also known to provide protective and therapeutic benefits against several diseases.

Chickpea (*Cicer arietinum*) is an important pulse crop grown and consumed all over the world, especially in the Afro-Asian countries. It is a good source of carbohydrates and protein, and the protein quality is considered to be better than other pulses. Chickpea

has significant amounts of all the essential amino acids. Starch is the major storage carbohydrate followed by dietary fibre, lipids are present in low amounts but chickpea is rich in nutritionally important unsaturated fatty acids like linoleic and oleic acid. Lactose free milk based on chick pea milk was developed and specially compared with "ISOMIL" (soy protein formula) in its nutritive value. Chickpea milk was fed to thirty infants of different nutritional status and blood parameters. The children recovered from diarrhea in less than five days case of lactose intolerance was found. Chickpea milk proved to be highly effective in the management of persistent diarrhea. Chickpea milk was highly effective in the management of persistent diarrhea and contains natural protein. Sensory acceptability of the cottage cheese added with seasoning was higher and more suitable for fortification with chick pea milk and different level of turmeric powder as seasoning like black pepper masked the chick pea flavor as these carrying antioxidant properties [28].

Rice is the seed of the grass species Oryza sativa (Asian rice) or *Oryza glaberrima* (African rice). Rice milk generally tastes sweeter than cow's milk, owing to the addition of sweeteners (usually brown rice syrup) and vanilla. It is also significantly higher in carbohydrates. There are not many advantages to rice milk over other plant-based milks, but it is likely the most hypoallergenic of all non-dairy alternatives. Though usually derived from boiled brown rice and brown rice starch, it has no fiber and a thin consistency. It has considerably less protein than cow's milk (only 1 g per 8 oz. cup) and a very small amount of natural calcium, though most brands are calcium-fortified and enriched with vitamins A, D, and B12. It is also low in fat; however, some manufacturers do add vegetable oil as an emulsifier and stabilizer.

Rice pudding is a dish made from rice mixed with water or milk and other ingredients such as cinnamon and raisins. Rice puddings are found in nearly every area of the world. Recipes can greatly vary even within a single country. The dessert can be boiled or baked. Different types of pudding vary depending on preparation methods and the selected ingredients. The pudding is usually partially cooked on top of the stove in a double boiler and then "finished" in an oven [29,30].

The aim of research is to evaluate the most common grains, as well as oats, maize, rice, and legumes such as chickpeas, soya, black eye and lima beans for using different grains in product plant milk then pudding rice by that plant milks. The physical, chemical physicochemical and microbiological qualities as well as the manufactured pudding rice characteristics were examined.

Materials and Methods

Materials

- Cow milk (82.45% water, 17.55% total solids, 3.19% fat, 3.30% protein, 4.61% lactose), was obtained from the Technology Center of Agriculture Production, Faculty of Agriculture, Cairo University**.**

- Grains samples: Three imported grains were obtained from U.S.A, Yellow Corn *(Zea mays),* Oats *(Avena sativa)* and Soya-Bean *(Glycine max)* grains which were obtained from (Alexandria) Government. Egyptian grains like Chick-Peas *(Cicer arietinum)* and Rice *(Oryza sativa)* were obtained from El-Bahara Government. White Lima-Bean *(Phaseolus vulgaris)* and Black Eyes-Bean *(Vigna unguiculata)* were obtained from El-Ghrbia Government. They were taken from seven different Companies since 2020. Media and reagents: the following solutions and media were used for mold enumeration and identification: Peptone water, Rose Bengal chloramphenical agar (Biolife, Italy).

Methods

Preparation of grains

A seventy kg of each grain samples used in this investigation were stored at temperature 25°c and relative humidity less than 62% and taken samples from stores according to the methods described [31]. Grains samples were cleaned mechanically to remove dirt, dockage, imparters and other strange grains by Carter Dockage Tester According to the methods described [32]. The samples were milled by Laboratory mill 3100 Perten according to the methods described [33]. The cereal ingredient (Black eye-bean, white lima-bean, soya-bean, Chickpeas, Yellow corn, Oats and Rice) was heated at 100°C for 15 min and then cooled to room temperature to reduce its microbial load.

Analytical methods

Physical properties

Cleanliness, dockage, splits, broken kernels, sound, foreign materials, total damaged kernels and total defects were separated and determined manually (hand picking). Test weight pound per bushel**,** Test weight P/B = (Kg / Hectoliter) ÷1.278 according to [34-37]. Hardness and thousand kernel weight was determined by counting the kernels in a 10 g of sample [33].

Chemical properties

Moisture, crude protein, vitamins, TS, ash, crude fiber, amino acid, minerals and fat were determined according [38] and Grains

Moisture according [39]. Carbohydrate was calculated by difference.

PH and titratable acidity

The pH of milk and pudding samples were measured according to the method [40], using a pH meter (HANNA, HI 9025) already standardized with buffer solutions of pH 4.0 and 7.0. Milk and pudding samples were analyzed for their acidity as reported [41].

Analytical methods

Microbiological analysis

Total mold count and fungal identification were carried out using Rose Bengal chloramphenical agar and incubated for 5-7 days at 25°C. Fungal identification was performed for isolated fungi in Food Safety Lab, Regional Center for Food & Feed, Agriculture Research Center and identified according [42].

For the enumeration of total aerobic bacteria (TAB), lactic acid bacteria (LAB), Yeast and Mould (YM) and Coliform Bacteria, samples of plant milk (vegetarian milk) (10 ml) and rice pudding (10 g) were dispersed in 90 ml sterile Ringer's solutions and appropriate decimal dilutions were prepared by using 1/4-strength Ringer's solution under the aseptic conditions. Total count of TAB was enumerated by Plate Count Agar (Oxoid) after incubation at 37°C for 48 hours [7]. LAB was counted on MRS agar containing 0.1 g/L of cycloheximide after incubation at 30°C for 72 h in anaerobic conditions [7]. Dichloran Rose Bengal Chloramphenicol Agar (Oxoid) was used for YM enumeration and plates were incubated at 25°C for 5 days [7]. Coliform bacteria were enumerated on Violet Red Bile Agar (Oxoid) after incubation at 37°C for 24h [7]. Estimation of Aflatoxins content, Ochratoxin, Zearalenone and Fumonisin were determined by HPLC using the method [38].

Viscosity

Viscosity was measured at 25, 40 and 60°C using the Brookfield rotational viscometer (model Brookfield DV- III ultra-programmable rheometer BROOKFIELD ENGINEERING LABORATORIES, INC., 11 Commerce Boulevard, Middleboro, USA) using No. 4 spindle at 20 rpm. Two readings were recorded for each sample [43].

Sensory evaluation

Rice pudding

Rice pudding of cow milk and rice pudding of plant milk were orgaolpticaly evaluated according to the method described [33]. The fresh sample was delivered to 10 panelists 2 hours after cooking and cooling in refrigerator. The sensory evaluation of rice pudding was determined by the panelists to determine appearance, body and texture, colour, flavour, mouth feel and overall acceptability according [33].

Statistical analysis

Data of three replicates were determined by Statistical Analysis System software package. Analysis of variance was performed by ANOVA procedures. Significant differences between means were determined by Duncan's multiple range tests at a level of P = 0.05 [44].

Results and Discussion

Chemical properties of grains cultivars:

Chemical composition of different grains cultivars used in this study is given in table 1. Grains moisture content of different varieties ranged from (9.50 to 13.30%) for all studied samples. Oats had the highest value while chickpeas had lowest value among all samples. As regards protein content, Soya beans had the highest protein (36.30%) followed by White Lima beans (20.50%), while Rice (7.10%) had the lowest protein content. Additionally rice was lower in fat content (0.66%) and ash content (0.50) than the other grains. Ash content of all grains was found quite close to each other. However, highest ash content was observed in Soya beans (5.80%). The results of fiber showed that Black eye beans had significant the highest value (12.0%) while Rice had lowest value (1.30%) on the other hand carbohydrates % ranged from 22.80% (Soya beans) to 78.44% (Rice),but total calorie values % ranged from 308.80% (Black eye beans) to 406.50% (Soya beans).

Minerals for different grains

Minerals for different grains in table 1, it can be noticed that (Mg) ranged from 1.84 to 140.0 mg/100g for all samples, where Yellow corn had the highest Mg (140.0 mg/100g) followed by Chick peas and Black eye beans which have the lowest Mg(1.84 mg/100g). But for (Zn) which ranged 1.10 to 82.8 mg/100g for all samples. Oats had the highest Zn (82.8 mg/100g) followed by Yellow corn and Rice which have the lowest Zn. Moreover can be observed some micro element have the highest range for K (179.7 mg/100g) for soybeans, P (90.0 mg/100g) for yellow corn, Cu and Ca (11.0 - 57.0 mg/100g) for Black eyed beans and Mn (118.6 mg/100g) for oats. Moreover it can be observed that the highest Fe than stander in all samples is oats (108.0 mg/100g) and the lowest one is rice (0.80 mg/100g), but Na the highest value is white lima beans (6.2 mg/100g) and the lowest one is black eye beans (1.60 mg/100g). On other hand (Se) is ranged from (0.08 to 0.90

mg/100g), the highest one is black eye beans followed by rice and the lowest is white lima beans and yellow corn. This Standard is applied to be used for food and non-food purposes, and for export. Grains division into types which represented indices, characteristics, and quality norms of grains according to classes; obligatory requirements for grain, which guarantee human, animal, and environmental safety and health (condition, odor, and color of grain, infectiousness), (toxic elements, mycotoxins, and pesticides), (safety and industrial sanitation requirements) and (natural environment protection) approved [45]. These results agree with result obtained [46].

Vitamins for different grains

Vitamins of different grains cultivars used in this study are given in table 1 that Thiamine (B_1) of different grains ranged from (3.8 to 87.40%) for all studied samples. Soya beans had the highest value while Yellow corn had lowest value among all samples. As regards Riboflavin (B_2), Soya beans had the highest (B_2) (87.0%) followed by Chick peas (21.20%), while Oats and Yellow corn (1.40%) had the lowest (B_2). On other hand Niacin (B3) % ranges from 9.70% (Oats) to 79.0% (White lima beans). Additionally Rice was lower Pantothenic (B_5) is (10.10%) than other samples and the Oats is the lower in Pyridoxine (B_6) (11.90%) in completely in other grains. As regards, Soya beans had the highest in Folic Acid, Vitamin (E) and Vitamin (K), but Black eyed beans had the highest in Vitamin (C) in all samples. These results agree with result obtained [47] and recommended [48].

Physical properties of kernels

Mean value of physical properties of different grain cultivars are presented in table 2. The statistical analysis for test in all

Grains	Black eyed beans	Chick peas	White Lima beans	Oats	Rice	Soya beans	Yellow corn
Chemical composition %							
Moisture Content %	11.08^{bc}	9.50^{d}	11.0^{c}	13.30^{a}	12.0^{b}	10.0^{d}	13.20^{a}
Protein %	19.43^{c}	19.30^{c}	20.50^{b}	11.30^{d}	7.10^{f}	36.30^{a}	8.30^{e}
Fat %	4.0^{d}	4.70^{c}	1.10^{e}	5.80^{b}	0.66^{f}	18.90^{a}	4.0^{d}
Ash%	4.0^{b}	3.40^{b}	3.80^{b}	3.20^{b}	0.50^{c}	5.80^{a}	1.40^{c}
Fiber%	12.0^{a}	8.70^{b}	6.60^{c}	11.90^{a}	1.30^{e}	6.20^{c}	3.0^{d}
Carbohydrate %	48.77^{e}	54.40^{d}	57.60^{c}	54.50^{d}	78.44^{a}	22.80^{f}	70.10^{b}
Total caloric values %	308.80^{g}	337.10^{d}	322.30^{e}	315.40^{f}	348.10^{c}	406.50^{a}	349.60^{b}
Minerals, mg/100g							
Mg	1.84^{f}	79.0^{b}	4.20^{f}	45.0^{c}	25.0^{e}	28.0^{d}	140.0^{a}
Zn	3.37^{d}	2.76^{e}	1.79^{f}	82.8^{a}	1.10^{g}	4.89^{c}	14.0^{b}
K	116.65^{b}	-	2.0^{e}	1.16^{f}	115.0^{c}	179.7^{a}	37.0^{d}
P	27.629^{c}	2.52^{f}	3.0^{e}	1.28^{g}	11.5^{d}	70.4^{b}	90.0^{a}
Cu	11.0^{a}	0.656^{f}	4.90^{c}	7.75^{b}	0.22^{f}	1.658^{e}	4.0^{d}
Mn	1.528^{e}	0.73^{f}	1.90^{de}	118.6^{a}	10.90^{b}	2.517^{d}	5.0^{c}
Ca	57.0^{a}	5.70^{e}	31.96^{b}	0.13^{f}	28.0^{c}	27.7^{d}	0.30^{f}
Fe	8.27^{d}	4.31^{e}	2.50^{f}	108.0^{a}	0.80^{g}	15.70^{c}	30.0^{b}
Na	1.60^{d}	-	6.20^{a}	-	5.0^{b}	-	3.0^{c}
Se	0.90^{a}	-	0.08^{bc}	-	0.151^{b}	-	0.08^{bc}
Vitamins %							
Thiamine (B_1)	46.0^{b}	47.70^{b}	25.0^{c}	7.70^{d}	7.0^{de}	87.40^{a}	3.80^{e}
Riboflavin (B_2)	8.0^{d}	21.20^{b}	10.0^{c}	1.40^{f}	5.0^{e}	87.0^{a}	1.40^{f}
Niacin (B_3)	73.0^{b}	15.41^{d}	79.0^{a}	9.70^{e}	16.0^{d}	16.23^{d}	28.0^{c}
Pantothenic Acid (B_5)	14.96^{cd}	15.88^{c}	-	13.60^{d}	10.10^{e}	79.30^{a}	66.0^{b}
Pyridoxine (B_6)	35.70^{c}	53.50^{a}	18.0^{d}	11.90^{f}	16.0^{e}	37.30^{b}	53.0^{a}
Folic Acid (B_9)	-	-	34.0^{b}	2.0^{d}	8.0^{c}	37.5^{a}	3.0^{d}
Vitamin (E)	-	-	62.0^{b}	-	11.0^{d}	85.0^{a}	24.0^{c}
Vitamin (K)	-	-	37.60^{b}	-	10.0^{c}	47.0^{a}	-
Vitamin (C)	15.0^{a}	4.0^{b}	-	-	-	6.0^{b}	-

Table 1: Proximate analysis of kernels using for plant milk.

Means with the same letter in the same row are not significantly different at ($P < 0.05$). NFE = Nitrogen free extracts, (-) = Not determined.

samples. It can be concluded that the test weight for all samples which ranged from 79.0 to 55.40 pound per bushel. The same trend were observed in test weight where Chick peas the highest (79.0 p/b) and followed by Black eye beans (78.88 p/b) and the lowest value was Oats (55.40 p/b). More ever the foreign material among all samples ranged from 0.07 to 2%, and the highest were oats, either the lowest was Chick peas (0.07). Soya beans had highest percentage of splits (9.10%) while White lima beans had the lowest (0.20%) and the broken kernels of Rice was (0.50%) while the sound of Oats was (97.0%). For damage kernels which contest all types of damage, especially Soya beans which had highest damage kernels percentage (1.30%), while Chick peas had lowest percentage of damage kernels (0.30%). It can be noticed that all grains hadn't heat damage. More over from the same table noticed that all sample are free from insect and odor was Ok. The statistical analysis for Weight per 1000 kernels content was significantly differences between all grains which was ranged from 71.0 to 522.0 gm. the highest weight content noticed for Chick peas (522.0 gm), while the lowest weight content noticed for rice (71.0 gm). Then hardness of grains different from 47.0% to 83.0% for rice and soya beans, respectively. The Egyptian stander no. 1601/1986 and it's modification on 23/4/2002 [49] has obligation that the dockage % (first separated from sample) not exceed 1%, foreign material % not exceed 1%, total damage kernels % (heat damage, sprout damage, insect damage and mould damage kernels) not exceed than 4%. However that difference between wheat samples, all grain samples had grade one according [31,35-37].

Grains	Black eyed beans	Chick peas	White Lima beans	Oats	Rice	Soya beans	Yellow corn
Test Weight p/b	78.88 [a]	79.0 [a]	78.5 [a]	55.4 [d]	76.6 [b]	56.5 [d]	59.7 [c]
Foreign Materials%	0.10 [b]	0.07 [b]	0.10 [b]	2.0 [a]	0.50 [b]	0.50 [b]	0.50 [b]
Broken kernels%	-	-	-	-	0.50 [b]	-	1.0 [a]
Splits%	0.50 [b]	0.40 [b]	0.20 [bc]	-	-	9.10 [a]	-
Sound%	-	-	-	97.0	-	-	-
Damage Kernels%	0.60 [bc]	0.30 [c]	0.40 [c]	0.50 [bc]	1.0 [ab]	1.30 [a]	0.60 [bc]
Odor	Ok	Ok	Ok	Ok	Ok	Ok	Ok
Insect	Free	Free	Free	Free	Free	Free	Free
Grade	1	1	1	1	1	1	1
Weight per 1000 kernels gm	222.0 [e]	522.0 [a]	480.0 [b]	462.0 [c]	71.0 [g]	175 [f]	387.0 [d]
Hardness%	67.0 [b]	66.0 [b]	66.0 [b]	73.0 [ab]	47.0 [c]	83.0 [a]	61.0 [b]
Colour	Creamy	Beige	White	Yellow	White	Yellow	Yellow

Table 2: Physical properties of kernels using for plant milk.

Means with the same letter in the same row are not significantly different at ($P < 0.05$). (-) = Not determined.

Total Mold count log cfu/g and Mycotoxins content of grains

Result of isolated fungal species for grains are present in table 3. Data show that total mould count ranged between 1.0 to 2.0 log cfu/g Soya beans had highest total mould count and Chick peas had lowest total mould count. Oats had total mould count after Soya beans. Results in table 3 show that aflatoxin content in grains cultivars. It can be noticed that all samples had low aflatoxin content before storing under detection limit (0.5 ppb) for aflatoxin, ochratoxin, zearalenone, fumonisin. Thus, it can be concluded that all sample content of aflatoxins were under detection limit (0.5 ppb) of the stander Egyptian maximum (B1 = 10 ppb and total aflatoxin = 20 ppb).

Amino acids for different grains

The statistical analysis for amino acids in different grains cultivars used are given in table 4, that aspartic acid of different grains ranged from 0.08-11.0% for all samples. Chick peas had the significant highest value while rice had lowest value among all samples. And the alanine acid ranged from 0.05- 7.80%. Yellow corn had the highest value while rice had lowest value among all samples. Then, arginine of different grains ranged from (0.15 to 8.30%) for all studied samples. Chickpeas had the highest value while rice had lowest value among all samples. As regards Cystine, Yellow corn had the highest value (2.50%) while Rice (0.02%) had the lowest value. At the same trend with glutamic and glycine, oats had the

highest value while rice had lowest value among all samples, but leucine acid ranged from 0.09 - 13.70% for rice and yellow corn, respectively. On other hand lysine ranged from 0.07% (rice) to 7.20% (chick peas). Additionally, rice was lower in methionine (0.04%), histidine (0.01%), isoleucine (0.05%), phenylalanine (0.06%), proline (0.05%), serine (0.06%), threonine (0.07%)and tryptophan (0.06%) than other samples. However, highest tyrosine and valine was observed in (yellow corn) (3.40%) and oats (5.30%), respectively. These results agree with result obtained [47] and recommended [48].

Grains		Black eyed beans	Chick peas	White Lima beans	Oats	Rice	Soya beans	Yellow corn
Total Mold count log CFU/g		1.10 de	1.0 e	1.20 cd	1.50 b	1.30 c	2.0 a	1.07 e
Ochratoxin ppb		*	*	*	*	*	*	*
Zearalenone ppb		*	*	*	*	*	*	*
Fumonisin ppb		*	*	*	*	*	*	*
Aflatoxin ppb	B1	*	*	*	*	*	*	*
	B2	*	*	*	*	*	*	*
	G1	*	*	*	*	*	*	*
	G2	*	*	*	*	*	*	*
	Total	*	*	*	*	*	*	*

Table 3: Total Mold count log cfu/g and Mycotoxins content of grains.

Means with the same letter in the same row are not significantly different at (P < 0.05).* = under detection limit (0.50 ppb).

Amino Acids g/100g	Grains						
	Black eyed beans	Chick peas	White Lima beans	Oats	Rice	Soya beans	Yellow corn
Aspartic	8.65 c	11.0 a	10.06 b	8.90 c	0.08 f	5.112 e	6.80 d
Alanine	4.02 c	4.80 b	3.98 c	5.0 b	0.05 e	1.915 d	7.80 a
Arginine	7.10 b	8.30 a	4.78 d	6.90 c	0.15 f	3.153 e	4.80 d
Cystine	1.69 b	0.60 c	0.86 c	-	0.02 d	0.655 c	2.50 a
Glutamic	23.22 b	17.30 c	11.04 d	23.90 a	0.19 f	7.874 e	17.70 c
Glycine	2.72 d	3.70 bc	3.29 cd	4.90 a	0.07 f	1.88 e	4.20 b
Leucine	7.29 cd	8.70 b	6.73 d	7.40 c	0.09 f	3.309 e	13.70 a
Lysine	6.30 b	7.20 a	5.23 c	4.20 d	0.07 f	2.706 e	2.80 e
Methionine	1.90 b	1.10 c	0.99 c	2.50 a	0.04 e	0.547 d	1.90 b
Histidine	3.10 a	3.0 a	2.38 b	2.20 b	0.01 d	1.097 c	2.90 a
Isoleucine	4.08 b	4.80 a	4.11 b	3.90 b	0.05 d	1.971 c	3.90 b
Phenylalanine	5.10 a	5.50 a	4.49 b	5.30 a	0.06 d	2.122 c	5.40 a
Proline	4.81 b	3.80 c	3.54 c	4.70 b	0.05 e	2.379 d	8.40 a
Serine	3.06 c	3.70 b	5.19 a	4.20 b	0.06 e	2.357 d	5.70 a
Threonine	3.80 a	3.10 b	3.37 b	3.30 b	0.07 d	1.766 c	4.0 a
Tryptophan	0.96 a	0.90 a	0.92 a	-	0.06 c	0.591 b	0.90 a
Tyrosine	3.04 ab	3.0 ab	2.76 b	3.10 ab	-	1.539 c	3.40 a
Valine	5.20 ab	4.60 c	4.69 bc	5.30 a	0.08 e	2.029 d	5.0 abc

Table 4: Amino Acids of kernels using for plant milk as alternative milk.

Means with the same letter in the same row are not significantly different at (P < 0.05). (-) = Not determined.

Chemical properties of cow and plant milk

Chemical composition of different milk used in this study is given in table 5. Water content of different milk ranged from (85.20 to 92.60%) for all studied samples. Chick peas milk had the highest value while cow milk had lowest value among all samples. As regards protein content, white lima beans milk had the highest protein (4.61%) followed by Chick peas milk (4.0%), while Rice milk (0.28%) had the lowest protein content. The total solid of milk samples ranged between 17.55% and 3.06%. Cow milk had the highest value of total solid while chick peas had the lowest value, respectively. Additionally, rice milk was lower in fat content (0.07%) than other samples but cow milk had the highest value (3.19%). However, highest ash content was observed in cow milk (0.75%). The results of fiber showed that White lima beans milk had significant the highest value (0.80%). On other hand carbohydrates % ranged from 3.40% (Black eye beans milk) to 9.17% (Rice milk). On the other hand total calorie values % ranged from 26.50% (Oats milk) to 67.25% (White lima beans milk).

Plant Milk	Cow (Control)	Black eyed beans	Chick peas	White Lima beans	Oats	Rice	Soya beans	Yellow corn
Chemical Composition								
Water %	82.45 ^{e}	89.36 ^{bcd}	96.94 ^{a}	87.86 ^{d}	91.53 ^{bc}	94.32 ^{ab}	90.10 ^{bcd}	85.79 ^{de}
Protein %	3.30 ^{bc}	3.23 ^{c}	4.0 ^{ab}	4.61 ^{a}	0.40 ^{d}	0.28 ^{d}	3.90 ^{abc}	0.72 ^{d}
TS %	17.55 ^{a}	10.64 ^{d}	3.06 ^{h}	12.14 ^{c}	8.47 ^{f}	5.68 ^{g}	9.9 ^{e}	14.21 ^{b}
Fat %	3.19 ^{a}	2.05 ^{bc}	2.70 ^{ab}	2.49 ^{abc}	0.50 ^{d}	0.07 ^{d}	1.90 ^{bc}	1.80 ^{c}
Ash %	0.75 ^{a}	0.15 ^{b}	0.26 ^{b}	0.37 ^{ab}	0.28 ^{b}	0.10 ^{b}	0.28 ^{b}	0.10 ^{b}
Fiber %	0.58 ^{abc}	0.09 ^{d}	0.04 ^{d}	0.80 ^{a}	0.60 ^{ab}	0.30 ^{bcd}	0.50 ^{abc}	0.22 ^{cd}
Carbohydrates %	4.61 ^{d}	3.40 ^{f}	3.75 ^{ef}	6.60 ^{b}	5.10 ^{c}	9.17 ^{a}	3.86 ^{e}	6.79 ^{b}
Total caloric values %	60.35 ^{b}	44.97 ^{d}	55.30 ^{c}	67.25 ^{a}	26.50 ^{f}	38.43 ^{e}	48.14 ^{d}	46.24 ^{d}
Minerals mg/100g								
Mg	11.0 ^{b}	0.37 ^{d}	13.80 ^{a}	0.84 ^{d}	8.0 ^{c}	11.0 ^{b}	8.0 ^{c}	9.81 ^{bc}
Zn	0.40 ^{cd}	0.67 ^{c}	0.53 ^{cd}	0.35 ^{cd}	9.0 ^{a}	0.3 ^{cd}	0.12 ^{d}	3.56 ^{b}
K	145.0 ^{a}	23.53 ^{b}	-	0.40 ^{d}	0.60 ^{cd}	2.70 ^{c}	2.70 ^{c}	2.11 ^{cd}
P	91.0 ^{a}	5.98 ^{c}	0.50 ^{d}	0.60 ^{d}	2.62 ^{d}	2.60 ^{d}	2.60 ^{d}	18.10 ^{b}
Cu	-	2.20 ^{c}	0.13 ^{fg}	0.98 ^{e}	8.0 ^{b}	44.0 ^{a}	0.31 ^{f}	1.41 ^{d}
Mn	8.0 ^{b}	0.30 ^{d}	0.46 ^{d}	0.38 ^{d}	10.10 ^{a}	3.0 ^{c}	0.50 ^{d}	1.11 ^{d}
Ca	112.0 ^{a}	13.30 ^{b}	1.10 ^{d}	6.51 ^{c}	0.60 ^{d}	8.0 ^{c}	13.0 ^{b}	0.03 ^{d}
Fe	0.10 ^{d}	1.65 ^{cd}	0.86 ^{d}	0.60 ^{d}	15.0 ^{a}	0.02 ^{d}	4.0 ^{bc}	6.60 ^{b}
Na	42.0 ^{a}	0.32 ^{bc}	-	1.10 ^{b}	-	0.10 ^{c}	-	0.61 ^{bc}
Se	1.80 ^{a}	0.018 ^{b}	-	0.013 ^{b}	-	0.020 ^{b}	-	0.016 ^{b}
Vitamins %								
Thiamine (B_1)	0.04 ^{c}	0.32 ^{c}	8.40 ^{a}	4.15 ^{b}	1.03 ^{c}	1.02 ^{c}	10.06 ^{a}	0.80 ^{c}
Riboflavin (B_2)	0.20 ^{d}	1.05 ^{cd}	4.10 ^{b}	1.81 ^{c}	0.23 ^{d}	1.04 ^{cd}	10.2 ^{a}	0.30 ^{d}
Niacin (B_3)	0.13 ^{c}	0.39 ^{c}	2.80 ^{bc}	12.60 ^{a}	1.10 ^{bc}	2.39 ^{bc}	3.60 ^{bc}	4.80 ^{b}
Pantothenic Acid (B5)	0.43 ^{b}	3.10 ^{b}	2.10 ^{b}	-	1.90 ^{b}	1.10 ^{b}	13.80 ^{a}	13.80 ^{a}
Pyridoxine(B_6)	0.04 ^{e}	5.30 ^{c}	10.10 ^{a}	3.10 ^{d}	1.13 ^{e}	3.04 ^{d}	8.07 ^{b}	10.01 ^{a}
Folic Acid (B_9)	-	-	-	5.21 ^{b}	0.51 ^{d}	0.90 ^{c}	7.80 ^{a}	0.51 ^{d}
Vitamin (B_{12})	0.51	-	-	-	-	-	-	-

Vitamin (A)	37.0	-	-	-	-	-	-	-
Vitamin (C)	1.0 ^{bc}	2.10 ^{a}	0.70 ^{c}	-	-	-	1.20 ^{b}	-
Vitamin (D)	0.20	-	-	-	-	-	-	-
Vitamin (E)	0.80 ^{c}	-	-	11.83 ^{a}	-	0.47 ^{c}	0.9 ^{c}	5.10 ^{b}
Vitamin (K)	-	-	-	5.20 ^{b}	-	1.80 ^{c}	8.10 ^{a}	-
Microbial counts CFU/ml								
TAB	$9.2x10^{4a}$	$2.1x10^{4e}$	$3.4x10^{4bc}$	$2.8x10^{4d}$	$3.7x10^{4b}$	$2.7x10^{4d}$	$3.1x10^{4cd}$	$3.8x10^{4b}$
LAB	-	$1.9x10^{3b}$	$2.8x10^{3a}$	$2.1x10^{3b}$	$2.01x10^{3b}$	$1.1x10^{3c}$	$2.1x10^{3b}$	$2.2x10^{3b}$

Table 5: Proximate analysis of cow and plant milk.

Means with the same letter in the same row are not significantly different at ($P < 0.05$). (-) = Not determined, TS = Total solid.

Minerals for cow and plant milk

Minerals for different milk in table 5. It can be noticed that (Mg) ranged from 0.37 to 13.80 mg/100g for all samples, where Chick peas milk had the highest Mg (13.80 mg/100g) followed by Rice and Cow milk while Black eye beans milk have the lowest Mg (0.37 mg/100g). But for (Zn) which ranged 0.12 to 9.0 mg/100g for all samples. Oats milk had the highest Zn (9.0 mg/100g) followed by Yellow corn milk while Soya beans milk have the lowest Zn. Cow milk had significant the highest in k, p but rice milk the highest value in Cu for all milk samples. As regards Mn, oats had the highest value 10.10%, while cow milk had the highest in Ca value 112.0% for all milk samples. Moreover it can be observed that the highest Fe than stander in all samples is Oats milk (15.0 mg/100g). The results of Na and Se showed that cow milk had significant highest value 42.0 and 1.80%, respectively. This Standard is applied to be used for food and non-food purposes, and for export. Human, animal, and environmental safety and health (condition, odor, and color of grain, infectiousness), (toxic elements, mycotoxins, and pesticides), (safety and industrial sanitation requirements) and (natural environment protection) approved [45].

Vitamins for cow and plant milk

Vitamins of different milk used in this study are given in table 5 that thiamine (B_1) of different milk ranged from (0.04 to 10.06%) for all studied samples. Soya beans milk had the highest value while cow milk had lowest value among all samples. As regards, riboflavin (B_2), soya beans milk had the highest (B_2) (10.20%) followed by chick peas milk (4.10%), while cow milk (0.20%) had the lowest (B_2). On other hand Niacin (B3) % ranges from 0.13% cow milk to 12.60% for white lima beans milk. Additionally, cow milk was lower in Pantothenic (B_5) which was (0.43%) while soya beans and yellow corn milk had highest value (13.80%). However Cow milk was lower in Pyridoxine (B_6) (0.04%) in completely than other milk. However, highest Folic Acid was observed in soya beans milk 7.80%. The results of vitamins C showed that black eyed beans had significant highest value 2.1%, vitamins E showed that white Lima beans had significant highest value 11.83%, but vitamins K showed that soya beans had significant highest value 8.10%.These results agree with result obtained [47] and recommended [48].

Microbiological analysis

The microbiological quality of milk samples are shown table 5. Total aerobic bacterial counts (TAB) ranged between 2.1 X 10^4 (Black eye beans milk) to 9.2 X 10^4 cfu/ml (Cow milk). Similar of counts were observed the total count including milk samples refer [50]. It is found that lactic acid bacterial counts (LAB) of milk were 1.1 X 10^3 (Rice milk) to 2.8 X 10^3 cfu/ml (Chick peas milk). In addition, No coliform or yeasts and moulds were recovered from any of the milk samples (i.e. 10^{-1} dilution). Yeast, moulds and coliform bacteria were not found from any research samples within the first dilution analysis, this indicating no contamination in raw materials or during the manufacturing process.

Amino Acids for cow and plant milk

Amino acids for different milk used in this study are given in table 6, that highest aspartic and alanine was observed in cow milk (4.06 - 2.87%). Arginine of different milk ranged from (0.03 to 1.48%) for all studied samples. Cow milk had the highest value while rice milk had lowest value among all samples. At the same trend with cystine, glycine, leucine and Lysine acid, cow milk had the highest value 1.74, 7.98, 9.60 and 2.09%, respectively. As regards glutamic, oats milk had the highest value (5.10%). Additionally Rice milk was lower in Methionine (0.009%) than other samples and lower in Histidine (0.001%) in completely in other

Amino Acids g/100g	Plant Milk							
	Cow (Control)	Black eyed beans	Chick peas	White Lima beans	Oats	Rice	Soya beans	Yellow corn
Aspartic	4.06^{a}	2.02^{b}	1.98^{b}	2.01^{b}	1.78^{c}	0.01^{f}	1.02^{e}	1.26^{d}
Alanine	2.87^{a}	0.38^{b}	0.94^{b}	0.79^{b}	1.20^{b}	0.011^{b}	0.25^{b}	1.31^{b}
Arginine	1.48^{a}	1.24^{ab}	1.31^{a}	0.98^{ab}	1.35^{a}	0.03^{c}	0.63^{b}	0.98^{ab}
Cystine	1.74^{a}	0.12^{c}	0.10^{c}	0.17^{c}	0.0	0.01^{c}	0.015^{c}	0.51^{b}
Glutamic	3.24^{ab}	4.46^{ab}	3.14^{ab}	2.02^{ab}	5.10^{a}	0.02^{b}	1.18^{ab}	3.11^{ab}
Glycine	7.98^{a}	0.24^{b}	0.74^{b}	0.71^{b}	1.0^{b}	0.01^{b}	0.24^{b}	0.62^{b}
Leucine	9.60^{a}	0.82^{bc}	1.71^{bc}	1.18^{bc}	2.30^{b}	0.02^{c}	0.71^{bc}	1.21^{bc}
Lysine	2.09^{a}	0.92^{ab}	1.34^{ab}	1.01^{ab}	0.30^{b}	0.01^{b}	0.56^{b}	0.46^{b}
Methionine	0.0	0.72^{a}	0.21^{ab}	0.21^{ab}	0.51^{ab}	0.009^{b}	0.23^{ab}	0.51^{ab}
Histidine	2.44^{a}	0.52^{bc}	0.56^{bc}	0.44^{bc}	0.60^{bc}	0.001^{c}	0.21^{c}	1.0^{b}
Isoleucine	9.85^{a}	0.84^{bc}	0.86^{bc}	0.86^{bc}	0.91^{bc}	0.01^{c}	0.22^{bc}	1.51^{b}
Phenylalanine	0.0	0.36^{c}	1.12^{b}	0.98^{b}	1.02^{b}	0.01^{d}	0.16^{cd}	1.65^{a}
Proline	2.83^{a}	0.04^{c}	0.66^{b}	0.96^{b}	0.94^{b}	0.011^{c}	0.01^{c}	1.10^{b}
Serine	2.17^{a}	0.85^{bc}	0.57^{c}	1.05^{b}	1.05^{b}	0.011^{d}	0.20^{d}	0.86^{bc}
Threonine	1.16^{a}	0.68^{ab}	0.49^{bc}	0.86^{ab}	0.97^{ab}	0.012^{c}	0.51^{bc}	0.67^{ab}
Tryptophan	0.0	0.76^{a}	0.51^{b}	0.15^{c}	0.0	0.011^{c}	0.06^{c}	0.01^{c}
Tyrosine	8.92^{a}	0.2^{b}	0.32^{b}	0.54^{b}	0.81^{b}	0.0^{b}	0.30^{b}	0.81^{b}
Valine	1.52^{a}	0.86^{c}	1.18^{b}	1.51^{a}	1.03^{bc}	0.013^{d}	1.01^{bc}	1.02^{bc}

Table 6: Amino Acids of Plant milk.

Means with the same letter in the same row are not significantly different at ($P < 0.05$).

milk. However, cow milk had significant highest value of isoleucine, proline, serine, threonine and tyrosine. The highest value of phenylalanine was observed in yellow corn (1.65%). The results of Tryptophan showed that black eye beans milk had significant highest value (0.76%). These results agree with result obtained [47] and recommended [48].

pH values and titratable acidity for different milk

pH of the milk which is closely related to the acidity of the milk is importance in the dairy industry. pH of the milk determine the storage stability of milk. The pH values and titratable acidity (% as lactic acid) of prepared milk samples were determined and the data illustrated by figure 1 and 2. Cow milk had lower than other milk samples prepared from grains in pH. Then milk prepared from grains (Rice, Oats, Yellow corn and Chick peas) had the lowest titratable acidity compared to cow milk. But milk prepared from Lima beans and Black eyed beans had high titratable acidity in all samples (Figure 2).

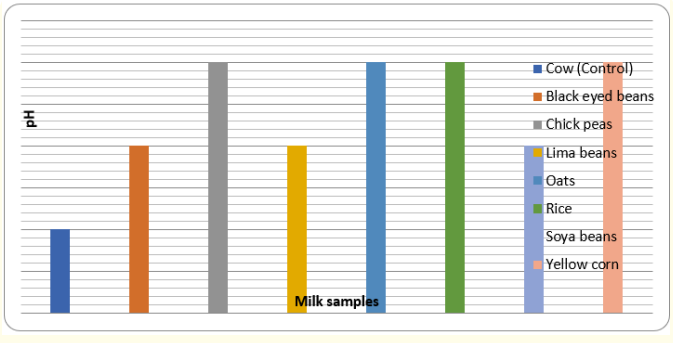

Figure 1: pH values of plant milk prepared from different grains compared with cow milk.

Viscosity of milk

Functional properties of cow and plant milk samples are summarized in figure 3. The Rice milk was characterized with the highest viscosity values during increasing heat treatment (25, 40 and 60°C)

as compared with containing of Cow milk was decreasing. A high significant ($P < 0.05$) value of viscosity was obtained for Rice milk (4.4, 4.8 and 5.0 cp/s) compared to the Cow milk in order of the other milk (2.0, 1.5 and 1.0 cp/s respectively). In [51] determined that the viscosity of plant milk was increased with increasing heat treatments. Also, [52] reported that the viscosity of different samples of wheat, barley, Soyabeans and oats vary considerably, and that the viscosity values are affected by heat treatment these due to pointed out that there is a relationship between the water binding capacity, heat treatment and the viscosity of the product. Also, [53] explained the reason for arabinoxylans and β-glucans are the two most important water-extractable dietary fiber polysaccharides in cereal food products and its determined their physical properties like viscosity, extractability, solubility and gelling behavior, as well as nutritional properties.

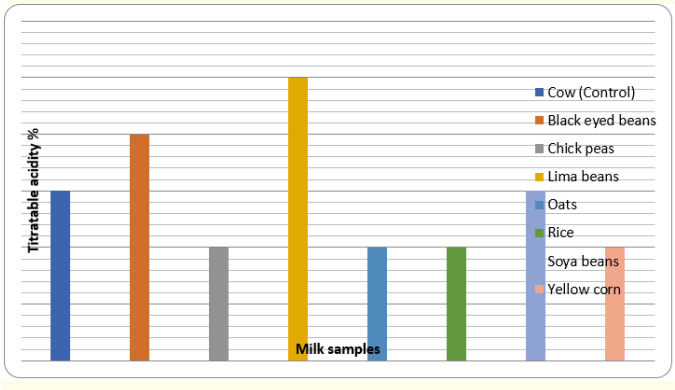

Figure 2: Acidity (%) of plant milk prepared from different grains compared with cow milk.

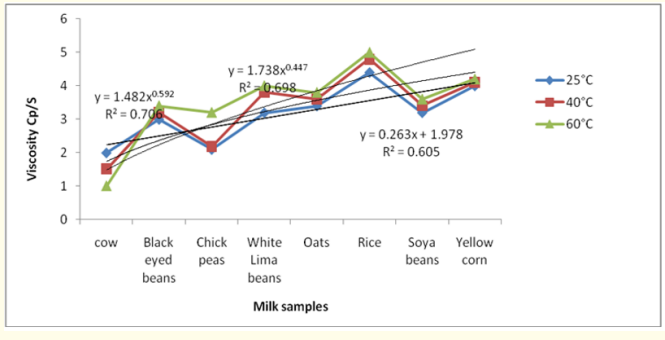

Figure 3: Viscosity of milk samples at different temperature.

Chemical properties of cow and plant rice pudding

Chemical composition of different rice pudding used in this study is given in table 7. Water content of different rice pudding ranged from (66.33to 78.36%) for all studied samples. Rice pudding of yellow corn milk had the highest value (78.36%) while Rice pudding of cow milk had lowest value (66.33%) among all samples. As regards, protein content of different rice pudding ranged from (1.70% to 6.02%) for all studied samples. Rice pudding of cow milk had the highest total solid content (33.67%) followed by rice pudding of white lima beans milk (28.44%), while no significant effect for the other samples. Additionally rice pudding of rice milk was lower in fat content (0.20%) than other samples but rice pudding of cow milk had the highest value (3.32%). However, highest ash content was observed in rice pudding of cow milk (0.79%). The results of fiber showed that rice pudding of white lima beans milk had significant the highest value (1.06%) while rice pudding of chick peas milk had lowest value (0.30%).On other hand carbohydrates % ranged from 52.11% (rice pudding of cow milk) to 68.81% (rice pudding of rice milk). On the other hand total calorie values % ranged from 252.99% (rice pudding of black eye beans milk) to 287.61% (rice pudding of yellow corn).

Minerals for rice pudding

Minerals for different rice pudding in table 7. It can be noticed that (Mg) ranged from 5.38 to 18.70 mg/100g for all samples, where Rice pudding of chick peas milk had the highest Mg (18.70 mg/100g). But for (Zn) which ranged 0.35 to 9.2 mg/100g for all samples. Rice pudding of Oats milk had the highest Zn (9.0 mg/100g) followed by Rice pudding of Yellow corn milk. Cow milk pudding had the significant highest value of K (168.0 mg/100g) and P (93.25 mg/100g), but rice had the significant highest value of Cu (44.04 mg/100g) in all samples. Rice pudding of oats milk had the highest value of Mn (12.38 mg/100g) while rice pudding of rice had lowest value (5.18 mg/100g) among all samples. Then cow milk pudding had the significant highest value of Ca (117.61 mg/100g). Moreover it can be observed that the highest Fe than stander in all samples is rice pudding of oats milk (15.6 mg/100g) and the lowest one is Rice pudding of rice milk (0.18 mg/100g). On other hand, the significant highest value of Na and Se is 43.1 and 1.83 mg/100g. This Standard is applied to be used for food and non-food purposes, and for export. Human, animal, and environmental safety and health (condition, odor, and color of grain, infectiousness), (toxic elements, mycotoxins, and pesticides), (safety and industrial sanitation requirements) and (natural environment protection) approved [45].

Vitamins for rice pudding

Vitamins of different rice pudding used in this study are given in table 7 that Thiamine (B_1) of different rice pudding ranged from

(1.45 to 11.48%) for all studied samples. Rice pudding of soya beans milk had the highest value (11.48%). As regards Riboflavin (B_2), Rice pudding of soya beans milk had the highest (B_2) (11.25%) followed by Rice pudding of chick peas milk (5.15%), while Rice pudding of oats and cow milk (1.20%) had the lowest (B_2). On other hand Niacin (B3) % ranges from 3.33% (Rice pudding of Cow milk) to 15.81% (Rice pudding of White lima beans milk). Additionally Rice pudding of White lima beans milk was lower in Pantothenic (B_5) which was (2.02%) while Rice pudding of soya beans milk had highest value (15.82%). However rice pudding of cow milk was lower in pyridoxine (B_6) (3.24%) in completely than other milk. On the other hand folic acid (B_9) and vitamin (K) were highest in rice pudding of soya beans milk while rice pudding of white lima beans milk was highest in vitamin (E). These results agree with result obtained [47] and recommended [48].

Microbiological analysis

The microbiological quality of rice pudding are shown table 7. Total aerobic bacterial counts (TAB) ranged between $3.4X10^4$ cfu/ml (rice pudding of black eye beans milk) to $10.5X10^4$ cfu/ml (rice pudding of cow milk). Similar of counts were observed the total count including milk samples refer to [50]. It is found that lactic acid bacterial counts (LAB) of rice pudding were $2.5X10^3$ (Rice pudding of Black eye beans milk) to $8.6X10^3$ cfu/ml (rice pudding of cow milk). In addition, No coliform or yeasts and moulds were recovered from any of the milk samples (i.e. 10^{-1} dilution). Yeast, moulds and coliform bacteria were not found from any research samples within the first dilution analysis, this indicating no contamination in raw materials or during the manufacturing process.

Rice pudding	Cow Control	Black eyed beans	Chick peas	White Lima beans	Oats	Rice	Soya beans	Yellow corn
Chemical composition								
Water %	66.33^{e}	75.98^{b}	74.48^{bc}	71.56^{d}	73.63^{c}	74.13^{c}	74.89^{bc}	78.36^{a}
Protein %	4.72^{a}	4.63^{a}	5.45^{a}	6.02^{a}	1.85^{b}	1.70^{b}	5.30^{a}	2.17^{b}
TS %	33.67^{a}	24.02^{b}	25.52^{b}	28.44^{ab}	26.37^{b}	25.87^{b}	25.11^{b}	21.64^{b}
Fat %	3.32^{a}	2.19^{ab}	2.84^{ab}	2.63^{ab}	0.64^{c}	0.20^{c}	2.0^{ab}	1.93^{b}
Ash %	0.79^{a}	0.24^{c}	0.30^{bc}	0.27^{c}	0.04^{e}	0.15^{d}	0.35^{b}	0.04^{e}
Fiber %	0.85^{ab}	0.36^{b}	0.30^{b}	1.06^{a}	0.88^{ab}	0.60^{ab}	0.78^{ab}	0.50^{ab}
Carbohydrates %	52.11^{d}	53.69^{cd}	53.50^{cd}	59.78^{bc}	64.71^{ab}	68.83^{a}	54.56^{cd}	65.39^{ab}
Total caloric values %	257.20^{cd}	252.99^{d}	261.36^{c}	286.87^{a}	272.0^{b}	283.92^{a}	257.44^{cd}	287.61^{a}
Minerals mg/100g								
Mg	16.0^{a}	5.38^{b}	18.7^{a}	5.80^{b}	13.10^{a}	16.20^{a}	13.20^{a}	14.85^{a}
Zn	0.62^{c}	0.87^{c}	0.75^{c}	0.60^{c}	9.20^{a}	0.50^{c}	0.35^{c}	3.80^{b}
K	168.0^{a}	46.50^{b}	23.10^{c}	23.40^{c}	23.60^{c}	25.50^{c}	25.70^{c}	25.20^{c}
P	93.25^{a}	8.30^{c}	2.80^{c}	2.91^{c}	4.60^{c}	4.90^{c}	4.91^{c}	20.50^{b}
Cu	0.05^{d}	2.25^{c}	0.17^{cd}	1.02^{cd}	8.02^{b}	44.04^{a}	0.34^{cd}	1.75^{cd}
Mn	10.18^{b}	2.50^{d}	2.70^{d}	2.60^{d}	12.38^{a}	5.18^{c}	2.68^{d}	3.29^{d}
Ca	117.61^{a}	18.90^{b}	6.70^{c}	6.0^{c}	15.70^{b}	8.60^{c}	6.10^{c}	6.71^{c}
Fe	0.26^{d}	1.82^{cd}	1.02^{d}	0.76^{d}	15.16^{a}	0.18^{d}	4.16^{c}	6.86^{b}
Na	43.1^{a}	1.32^{b}	1.10^{b}	2.13^{b}	1.0^{b}	1.1^{b}	1.20^{b}	1.62^{b}
Se	1.83^{a}	0.048^{b}	0.03^{b}	0.043^{b}	0.03^{b}	0.05^{b}	0.03^{b}	0.046^{b}
Vitamins %								
Thiamine (B_1)	1.45^{c}	1.70^{c}	9.90^{a}	5.55^{b}	2.44^{c}	2.41^{c}	11.48^{a}	2.20^{c}
Riboflavin (B_2)	1.20^{e}	2.05^{d}	5.15^{b}	2.82^{c}	1.20^{e}	2.0^{d}	11.25^{a}	1.35^{e}
Niacin (B_3)	3.33^{b}	3.59^{b}	5.98^{b}	15.81^{a}	4.3^{b}	5.50^{b}	6.81^{b}	7.91^{b}
Pantothenic Acid (B_5)	2.45^{cd}	5.12^{b}	4.12^{bc}	2.02^{d}	3.0^{cd}	3.10^{cd}	15.82^{a}	15.80^{a}
Pyridoxine (B_6)	3.24^{d}	8.51^{bc}	13.31^{a}	6.35^{cd}	4.32^{d}	6.25^{cd}	11.29^{ab}	13.21^{a}
Folic Acid (B_9)	1.60^{c}	1.61^{c}	1.58^{c}	6.85^{b}	2.1^{c}	2.60^{c}	8.90^{a}	2.25^{c}
Vitamin (E)	3.0^{d}	2.0^{g}	2.1^{f}	13.80^{a}	2.13^{f}	2.71^{e}	3.11^{c}	7.30^{b}
Vitamin (K)	1.50^{f}	1.80^{def}	1.60^{ef}	7.2^{b}	2.0^{de}	4.0^{c}	10.10^{a}	2.10^{d}
Microbial counts CFU/mg								
TAB	$10.5x10^{4a}$	$3.4x10^{4b}$	$4.7x10^{4b}$	$4.1x10^{4b}$	$5.0x10^{4b}$	$4.0x10^{4b}$	$4.4x10^{4b}$	$5.1x10^{4b}$
LAB	$8.6x10^{3a}$	$2.5x10^{3b}$	$3.1x10^{3b}$	$2.9x10^{3b}$	$4.2x10^{3b}$	$3.2x10^{3b}$	$2.8x10^{3b}$	$4.0x10^{3b}$

Table 7: Proximate analysis of cow and plant rice pudding.

Means with the same letter in the same row are not significantly different at ($P < 0.05$). TS = Total solid, (-) = Not determined.

Amino acids for rice pudding

Amino Acids for different rice pudding used in this study are given in table 8, that highest aspartic, alanine, arginine and Cystine was observed in rice pudding of cow milk (4.08, 2.88,1.52 and 1.75%). but oats had the highest value of glutamic acid 5.14%. Then, glycine, leucine and lysine, rice pudding of cow milk had the highest value (7.99, 9.62 and 2.11%) while rice pudding of cow milk and rice pudding of rice milk had the lowest value in methionine (0.01, 0.02%). Additionally, rice pudding of rice milk lower in Histidine (0.003%) in completely in other rice pudding. However, highest isoleucine, proline, serine, threonine and tyrosine were observed in rice pudding of cow milk (9.86, 2.84, 2.18, 2.17and 8.92%). The results of Tryptophan showed that rice pudding of Black eye beans milk had significant highest value (0.77%). On other hand valine ranged from 0.030% (rice pudding of rice milk) to 1.54% (rice pudding of cow milk). These results agree with result obtained [47] and recommended [48].

pH Values and Titratable Acidity for Different rice pudding

The pH values and titratable acidity (% as lactic acid) of prepared pudding samples were determined and the data illustrated by figure 4 and 5. Pudding milk prepared from black eyed beans had the highest pH value 8.10% and acidity 0.20% compared to other treatments, but cow milk had lowest pH. Titratable acidity increased, from 0.05%, in rice and yellow corn milk, to a maximum level of 0.25% in lima beans (Figure 5).

Viscosity of rice pudding

The rice pudding of black eye beans milk were characterized with the highest viscosity values during increasing heat treatment (25, 40 and 60°C) as compared with containing of rice pudding of oats milk was increasing too. A high significant ($P < 0.05$) value of viscosity was obtained for rice pudding of rice milk (12000, 14200 and 16800 cp/s respectively) compared to the rice pudding of oats milk (7600, 8600 and 12600 cp/s respectively) in order of the other rice pudding in figure 6. Gamli., *et al*. [54] determined that the viscosity of rice pudding was increased with increasing heat treatments. Also, [52] reported that the viscosity of different samples of wheat, barley, Soya beans and oats vary considerably, and that the viscosity values are affected by heat treatment these due to pointed out that there is a relationship between the water binding capacity, heat treatment and the viscosity of the product. Also, [53]

Amino acids g/100g	Rice pudding							
	Cow (Control)	Black eyed beans	Chick peas	Lima beans	Oats	Rice	Soya beans	Yellow corn
Aspartic	4.08^{a}	2.04^{b}	2.0^{b}	2.03^{b}	1.80^{b}	0.03^{c}	1.04^{bc}	1.28^{b}
Alanine	2.88^{a}	0.39^{cde}	0.95^{bc}	0.81^{bcd}	1.30^{b}	0.02^{e}	0.28^{de}	1.33^{b}
Arginine	1.52^{a}	1.27^{ab}	1.34^{ab}	1.02^{bc}	1.39^{ab}	0.09^{d}	0.69^{c}	1.02^{bc}
Cystine	1.75^{a}	0.13^{cd}	0.15^{c}	0.22^{c}	0.01^{d}	0.02^{d}	0.019^{d}	0.55^{b}
Glutamic	3.28^{ab}	4.50^{a}	3.18^{ab}	2.06^{bc}	5.14^{a}	0.06^{c}	1.22^{bc}	3.15^{ab}
Glycine	7.99^{a}	0.25^{b}	0.75^{b}	0.72^{b}	1.01^{b}	0.02^{b}	0.25^{b}	0.63^{b}
Leucine	9.62^{a}	0.84^{cd}	1.73^{bc}	1.20^{bcd}	2.32^{b}	0.04^{d}	0.73^{cd}	1.23^{bcd}
Lysine	2.11^{a}	0.94^{bc}	1.36^{b}	1.03^{bc}	0.32^{de}	0.03^{e}	0.58^{cd}	0.48^{de}
Methionine	0.01^{b}	0.73^{a}	0.22^{ab}	0.23^{ab}	0.52^{ab}	0.02^{b}	0.24^{ab}	0.52^{ab}
Histidine	2.44^{a}	0.52^{bcd}	0.56^{bc}	0.44^{cd}	0.60^{bc}	0.003^{d}	0.21^{cd}	1.01^{b}
Isoleucine	9.86^{a}	0.85^{bc}	0.87^{bc}	0.88^{bc}	0.92^{bc}	0.02^{c}	0.23^{bc}	1.52^{b}
Phenylalanine	0.01^{d}	0.37^{c}	1.13^{b}	0.99^{b}	1.03^{b}	0.022^{d}	0.18^{cd}	1.66^{a}
Proline	2.84^{a}	0.05^{d}	0.67^{c}	0.97^{bc}	0.95^{bc}	0.013^{d}	0.022^{d}	1.11^{b}
Serine	2.18^{a}	0.86^{bc}	0.58^{c}	1.06^{b}	1.06^{b}	0.023^{d}	0.21^{d}	0.87^{bc}
Threonine	2.17^{a}	0.69^{b}	0.50^{bc}	0.87^{b}	0.98^{b}	0.026^{c}	0.524^{bc}	0.68^{b}
Tryptophan	0.012^{c}	0.77^{a}	0.52^{b}	0.16^{c}	0.09^{c}	0.023^{c}	0.072^{c}	0.022^{c}
Tyrosine	8.92^{a}	0.20^{b}	0.32^{b}	0.54^{b}	0.81^{b}	0.0	0.30^{b}	0.81^{b}
Valine	1.54^{a}	0.88^{b}	1.20^{ab}	1.53^{a}	1.05^{b}	0.03^{c}	1.03^{b}	1.04^{b}

Table 8: Amino acids of cow and rice pudding.

Means with the same letter in the same row are not significantly different at ($P < 0.05$). (-) = Not determined.

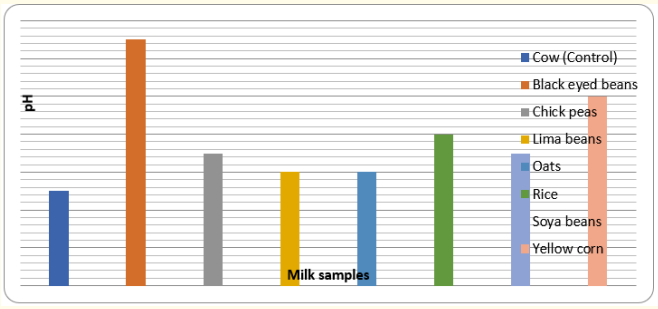

Figure 4: pH values of rice pudding product prepared from plant milk and compared with cow milk.

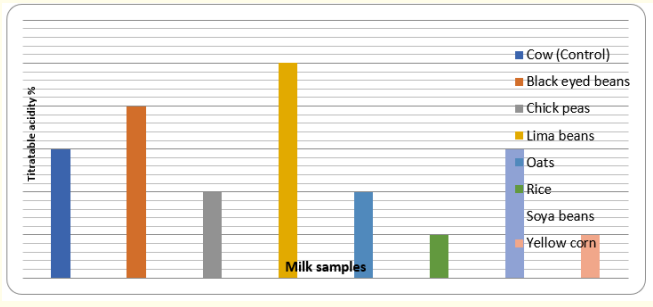

Figure 5: Acidity (%) of rice pudding product prepared from plant milk and compared with cow milk.

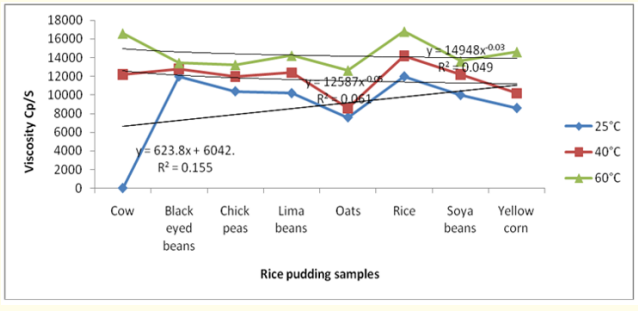

Figure 6: Viscosity of rice pudding of milk samples at different temperature.

explained the reason for arabinoxylans and β-glucans are the two most important water-extractable dietary fiber polysaccharides in cereal food products and its determined their physical properties like viscosity, extractability, solubility and gelling behavior, as well as nutritional properties. And these results agree with result obtained [55].

Sensory evaluation

Sensory evaluation of rice pudding samples had significant differences ($p < 0.05$) were observed in appearance, body and texture, colour, taste, flavor, mouth feel and overall acceptability. Data in table 9 showed the sensory evaluation of rice pudding made from different milk. It can be noticed that control rice pudding of cow milk had highest total scores than the rice pudding of rice milk and rice pudding of Yellow corn milk 99.16, 91.98 and 90.65% respectively. Rice pudding prepared from different milk were subjected to sensory evaluation for appearance, body and texture, colour, taste, flavor and mouth feel each their mean scores were calculated (Table 9). Highest mean score for colour (19.83) were obtained by rice pudding of cow milk. The low score of rice pudding of black eye bean milk and rice pudding of chick peas milk may be due to high fiber and ash content, which affect the colour of milk since consumers prefer creamy colour and not dark rice pudding. In case of flavor, rice pudding of cow milk was at the top (19.83) followed by rice pudding of yellow corn milk (18.16) and rice pudding of rice milk (17.83). Maximum appearance score (20.0) were attained by Rice pudding of Cow milk while rice pudding of soya bean milk and rice pudding of chick peas milk received the minimum score (11.50 and 11.52, respectively). Rice pudding of chick peas milk obtained the least score (16.50) for body and texture whereas rice pudding of cow milk, rice pudding of oats milk, rice pudding of yellow corn milk and black eyed beans received the highest score (19.50, 19.0, 19.0 and18.83 respectively). The differences in colour, appearance and flavour of all the rice pudding were attributed to the differences of grains milk and other factors like varieties and characteristics of grains. For mouth feel, highest mean score (20.0) were obtained by rice pudding of cow milk while lowest score (9.83) was obtained by rice pudding of Soya bean milk thus considered least acceptable. This results are parallel with the results obtained [33].

Conclusion

In conclusion, examination of selected physical properties showed significant differences among rice pudding containing plant milks compared with the rice pudding containing 100% cow milk. The results of our experiment showed that the rice pudding of plant milk higher titratable acidity and protein content, which suggesting it is better nutritional and good quality. The addition of cow pudding gave a higher acceptability of all samples. And sensorial, rice pudding of rice, yellow corn, oats and Lima beans milk samples are more acceptability than other treatment after rice pudding of cow milk control. The plant milks can be used in the production

Plant rice pudding	Appearance 20	Body and texture 20	Colour 20	Flavor 20	Mouth feel 20	Overall 100
Cow (Control)	20.0^{a}	19.5^{a}	19.83^{a}	19.83^{a}	20.0^{a}	99.16^{a}
Black eyed beans	12.50^{b}	18.83^{a}	12.50^{c}	12.33^{c}	10.50^{de}	66.66^{d}
Chick peas	11.52^{b}	16.50^{b}	15.50^{bc}	15.16^{bc}	14.16^{c}	72.84^{c}
Lima beans	13.33^{ab}	17.66^{ab}	18.0^{ab}	13.0^{c}	12.0^{d}	73.99^{c}
Oats	14.33^{ab}	19.0^{a}	12.83^{c}	17.0^{ab}	14.0^{c}	77.16^{c}
Rice	18.66^{ab}	18.33^{ab}	18.66^{ab}	17.83^{ab}	18.50^{ab}	91.98^{b}
Soya beans	11.50^{b}	18.16^{ab}	13.66^{c}	12.50^{c}	9.83^{e}	65.65^{d}
Yellow corn	17.16^{ab}	19.0^{a}	18.50^{ab}	18.16^{ab}	17.83^{b}	90.65^{b}

Table 9: Sensory evaluation of cow and plant rice pudding.

Means with the same letter in the same column are not significantly different at ($P < 0.05$).

of functional rice pudding with significant nutritional and therapeutic properties and also with high physical quality and overall acceptability.

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