

Comparative Study on Antioxidant Vitamin Constituents and Selected Mineral Composition of Milk from Local Rice and Foreign Rice

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Abstract

Plant milk are extracts from plant sources, obtained by grinding or mashing plant products (seeds/nuts) with water and then further filtering out the liquid. It is the alternative animal milk. The study is aimed at comparing the antioxidant Vitamin constituents and some selected mineral composition of milk from local and foreign rice. Calcium contents for milk sample LRS and FRS were (103 ± 1.63) and (92.00 ± 6.38) of which LRS was higher. Magnesium contents tend to be higher in LRS(122.7mg) compared to FRS(75.33mg). The potassium and sodium content of LRS were higher with the quantity as 126.7mg compare to FRS which is recorded as 121mg for potassium and 88.33mg and 89.70mg of sodium for FRS and LRS respectively. Milk sample of LRS revealed 114.3mg of copper when evaluated and FRS revealed 104.3mg. Zinc content of LRS increased to 115.3mg while FRS decreased to 45.23mg, Phosphorous content of milk samples ranged from (116.7 to 138 mg/100 g). LRS(138mg) was higher in phosphorus than FRS(116.7mg). Vitamin A content of foreign rice milk sample (FRS) had 0.13mg/100g when compared to the local rice milk sample(FRS) which had 0.12mg/100g. Vitamin C content of FRS was higher (1.33mg) than that of LRS (1.29mg). The vitamin E content of the two milk samples were evaluated and it was observed that LRS recorded a higher value of 0.43mg when compared to FRS(0.40mg). Milk extracted from local rice has proven to be a good source of minerals and vitamins among milk extracted from foreign rice. The minerals and vitamins in milk extracted from local rice can be consumed not only for its appetizing qualities but also for the higher nutritional qualities that can be obtained.

Keywords: Plant Milk, Local Rice, Foreign Rice, Vitamin, Selected Minerals.

Introduction

Alternatives to dairy milk are becoming increasingly popular for people with allergies and intolerance or for those who prefer a dairy-free diet. Consumers, however, may not always be aware of the differences in micronutrients content of plant-based milk alternatives when compared to dairy milk. Plant-based alternatives to milk are popular for health, ethical and environmental reasons. Many people may also prefer the taste of plant-based milk alternatives over regular cow's milk (Aadil, 2017)

Plant milk is water extracts of legumes, oil seeds, cereals or pseudo-cereals that resemble cow's milk in appearance. Continuous research efforts are underway to improve the organoleptic, nutritional and functional properties of the plant-based milk alternates. Four

major focus areas such as stability, removal of all impurities in the production and improvement of plant-based milk. Stability of such beverages is a function of off-flavor, inactivation/removal of inhibitors and shelf-life has been identified crucial of the size of the dispersed phase particles (fat globules, solid material particles, proteins, etc.) (Augustine *et al.*, 2015). Stabilizers are indispensable substances in food items and categorized as food additives. They smoothen the texture of the food by making the homogenous dispersion of two or more immiscible materials. Food products acquire a definite framework with well-maintained physicochemical attributes after their addition (Baer *et al.*, 2017). Rice is a food crop of world-wide importance and forms the foundation of the diet of over 3 billion people, constituting over half of the world's population (Aadil *et al.*, 2017). It is widely cultivated throughout the world and has become the second most important cereal in the world after wheat in terms of cultivation, due to a recent decline in maize production (Akinyele, 2012). Rice milk is a plant based or non-dairy milk alternative product. Rice milk is becoming a popular healthy drink among health-conscious consumers in terms of nutritional facts. Rice milk contains essential amino acids that promote growth, strengthen the immune system, has low cholesterol, low fat and no allergen. Milk alternatives, such as rice, oat, soy and almond are fluids which imitates cow's milk in terms of appearance and consistency (Basorun *et al.*, 2020). These milks are lactose-free and are perfect alternative products for people who suffer from lactose intolerance or for vegetarian persons.

Plant milk substitutes are colloidal suspensions or emulsions consisting of dissolved and disintegrated plant material. They are prepared traditionally by grinding the raw material into a slurry and straining it to remove coarse particles. Although countless variations of the process exist, the general outline of a modern industrial scale process is essentially the same: the plant material is soaked and wet milled to extract the milk constituents, or alternatively the raw material is dry milled and the flour is extracted in water (Figure 1). The grinding waste is separated by filtering or decanting (Ackerman *et al.*, 2015) Depending on the product, standardization and/or addition of other ingredients such as sugar, oil, flavorings and stabilisers may take place, followed by homogenization and pasteurization/UHT treatment to improve suspension and microbial stabilities. These extracts can also be spray dried to produce powders (Diarra *et al.*, 2015).

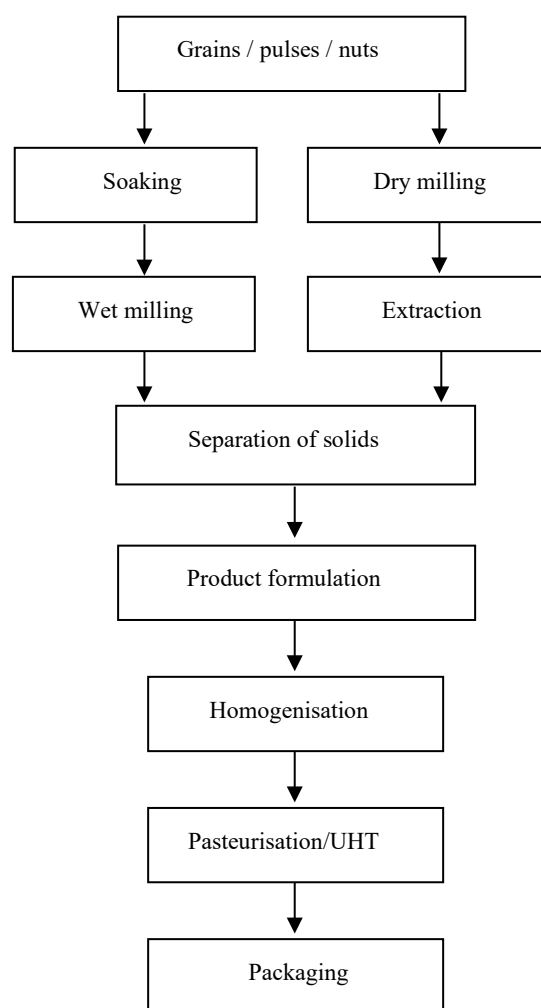


Figure 1: The flow chart for the production of plant milk (Boumas, 2015)

Health Benefits of Rice Milk

Rice milk provides health benefits, especially for those who can't consume dairy. Choosing fortified rice milk has advantages due to the nutrients that have been added to it, such as calcium and vitamin D. Calcium and vitamin D are excellent nutrients for bone health. Added vitamin B12 and calcium in rice milk are vital for preventing deficiencies that can be common on a vegan diet.

- Provides a Dairy Milk Alternative: Rice milk provides an easy-to-find alternative for those who have lactose intolerance or milk allergy. It is also vegan- and vegetarian friendly. Rice milk is considered to be the least allergic of all of the dairy and non-dairy milk choices. Most other options contain soy, gluten, milk protein, or nuts, which are all common allergens. Most brands of rice milk are simply made from brown rice and brown rice derivatives. In many ways, rice milk behaves just like dairy milk. It can be used in recipes and the taste is similar (but not exactly the same). A cup of low-fat (2%) dairy milk provides 122 calories, 8 grams of protein, 4.7 grams of fat, 12 grams of carbohydrate, and 12 grams of sugar. It also provides 309 milligrams of calcium, 2.8mcg of vitamin D, 1.4mcg of vitamin B12, and

203mcg of vitamin A. Most of the fat in milk is saturated fat, whereas rice milk contains no saturated fat. However, dairy milk contains more protein than rice milk. If you choose your enriched rice milk carefully, you can get similar nutrients from rice milk as you can from dairy milk.

- **Improves Bone Density:** The calcium in enriched rice milk is important for bone health and strength and may help prevent osteoporosis (a weakening of the bones that can cause fractures). Low calcium intake throughout life is associated with low bone mass and high fracture rates. Most people don't get the calcium they need to grow and maintain healthy bone. Since the body needs vitamin D to absorb calcium, the level of this vitamin in fortified rice milk is also important for bone health. You can increase your vitamin D levels by exposing yourself to sunlight. But since sun exposure can increase your risk of skin cancer, getting it in foods is preferable.

- **It Helps Prevent Vitamin B12 Deficiency:** Some people are likely to have lower levels of vitamin B12 because they don't absorb it properly or because their diet doesn't include foods rich in the nutrient. Older adults, vegetarians, vegans, people who have had gastrointestinal surgery, and those who have digestive disorders may need to take a vitamin B12 supplement or to look for foods that are fortified with it.

- **It Helps Prevent Calcium Deficiency:** Besides contributing to bone health, calcium also plays a role in communication between nerves and muscles. It helps maintain healthy blood vessels for circulation and is important for the release of various hormones and enzymes. Many people are at risk for calcium deficiency, including post-menopausal women. The National Institutes of Health also says that boys aged 9 to 13, girls aged 9 to 18, and men older than 70 often don't get enough calcium. The type of calcium often added to rice milk is calcium citrate, which can be absorbed on an empty or full stomach. It is also better absorbed by people with low levels of stomach acid or conditions including inflammatory bowel disease or absorption disorders (Kiln *et al.*, 2014)

Antioxidants as chemical constituents provides electron to the free radical and changes it to an inoffensive molecule (Olayinka *et al.*, 2012). Antioxidants are those materials that interrupt free radical and protect cells from the oxidative damage causing aging and diseases. It also thwarts injury to blood vessel membranes; it augments the flow of blood to the heart as well as the brain. It is a defensive measure against cancerous DNA and it lessens the hazard of cardiovascular diseases. Supply of antioxidants to the body system is via our eating, majority are obtained from fruits, grains and vegetables (Olayinka *et al.*, 2012). Therefore, developing alternative milk extracted from rice is recommended as their nutritional value could be used to replace animal milk. Considering the richness of such milk, they can be used for babies not given milk either for ethical reasons, or to vegans or for medical reasons on people with milk allergies (Ikemefuna *et al.*, 2013).

Aim and Objectives

The aim of this study is to compare the antioxidant Vitamin Constituents and Selected Mineral Composition of Milk from Local and Foreign Rice.

The specific objectives are

1. Produce alternative milk using local and foreign rice varieties
2. Evaluate the mineral composition of milk produced from local and foreign rice.
3. Evaluate the antioxidant vitamins of milk produced from foreign and local rice

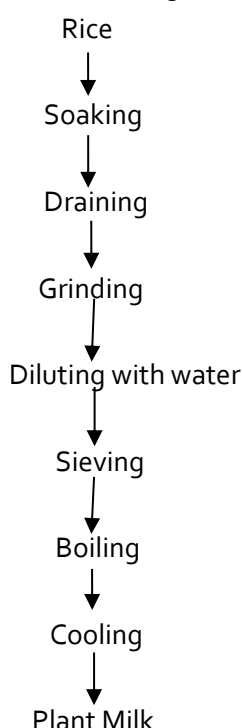
Material and Method

Source of Raw Materials

Two different varieties of rice, foreign rice (cap rice produced in Thailand) and local rice (Anambra rice produced in Omor). Two Kilogram (2kg) each were purchased from the local trader in Eke, Oko Market in Orumba North L.G.A. of Anambra State.

Sample Production

Two kilograms (2kg) of different rice were separately soaked overnight for 18hr in a 3litres of warm water to give a cereal: water ratio of 1:3 and rinsed with water. The cereals were then drained and rinsed with treated water. The drained rice was grinded with 750ml food processor (An electric blender). The resulting slurry was filtered through a muslin cloth and extract (milk) obtained with boiled for 15 mins.



The flows Chart for Production of the Plant Milk (Augustine *et al.*, 2015)

Methods

The vitamins were determined according to the methods described by Onwuka (2005).

Determination of Vitamin A

Vitamin A was determined by spectrophotometric, colorimetric, and fluorometric procedures. Colorimetric procedures with SbCl_3 were used to measure vitamin A (retinol) in the milk samples.

Determination of Vitamin C

Five grammes (5g) of the sample were dispersed in 50ml of EDTA/TCA Solution and homogenized. The homogenate was filtered with Whitman No 42-filter paper and more of the extracting solution was used to wash the residue in the filter paper until 50ml filtrate was obtained. A 20ml portion of the filtrate was measured into a conical flask and 10ml of 30% of KI solution was added to it, mixed well and then followed by 1% starch solutions. The mixture was titrated against 0.01M of CuSO_4 solution. A reagent blank was titrated. Vitamin C content was calculated based on the relationship that 1ml 0.01M CuSO_4 = 0.88mg vitamin C

Therefore vitamin C mg/100g = $100 \times 0.88 \times (t-b) \times v_t / w/v_a$

Where w – weight of sample

T – Titer value of sample

B - Titer value of blank

V_t – total extract volume

V_a – volume of extract titer

Determination of Vitamin E

The vitamin E was separated by column, paper, thin-layer, gas-liquid, and high-pressure liquid chromatography (HPLC). Gas-liquid chromatography was used to test for vitamin E in the milk samples.

Determination of some Minerals

The mineral contents of the milk samples were done following the dry ash extraction method described by Onwuka (2005). A measured weight of the sample was burnt to ashes (as in ash determination) thereby removing all the organic materials leaving the inorganic ash. The resulting ash was dissolved in 5 ml of dilute 2M. HCL solution and then dilute to 100 ml in a volumetric flask. This extract was used in specific analysis for the different mineral elements.

Determination of Calcium and Magnesium

Calcium and magnesium were determined by complexometric titration. The versante EDTA titrimetric method of AOAC (2005) was employed. 20 ml portion was dispersed into conical

flask and treated with pinches of the masking agents (hydroxylamine hydrochloride, sodium cyanide and sodium potassium ferrocyanide). The mask was added to it to raise the pH to 10.00 (a point at which both calcium and magnesium form complexes with EDTA). The mixture was titrated against 0.02N EDTA solution using Ferrochrome dark T as indicator. A reagent blank was titrated and titration in each case was done from deep red to a permanent blue end point. The titration value represents both Ca^{2+} and Mg^{2+} in the test sample. A reagent titration was done to determine Ca^{2+} alone in test samples. Titration of calcium alone was done in similarity with the above titration. However, 10% NaOH was used in place of the ammonia buffer and solo chrome dark blue indicator in place of Ferrochrome Black T. from the titer values obtained, the Ca^{2+} and Mg^{2+} content were calculated as shown below:

$$\% \text{Ca/Mg} = 100/W \times T - B(N \times \text{Ca/Mg})/v_a \times V_t$$

Where:

- T = titer value of sample
- V_t = total extract volume
- V_a = volume of extract analyzer
- W = weight of the sample
- B = titer value of blank
- Ca = calcium equivalence
- Mg = magnesium equivalence
- N = Normality of titrate (0.02 EDTA)

Determination of Phosphorus

The phosphorus in the sample was determined by molybdatevanadate calorimetric method. A measured volume of the volume of the dry ash (2mg) digest of the sample was dispersed into a 50 ml volume flask. At the same time, the same volume of distilled water and standard P solution were measured into different flask to serve as reagent blank and standard respectively. 2 ml of the phosphorus color reagent (molybdovanadate solution) was added to each of the flask and allowed to stand at room temperature for 15 minutes. The content of each flask was diluted to the 50 ml mark with distilled water and its absorbance was measured in a spectrophotometer at a wavelength of 540m with the reagent blank at zero. The phosphorus content was calculated using the formula below:

$$P \text{ mg/100g} = 100/W \times a_u/a_s \times C \times v_t / v_a$$

Where: w = weight of sample

- A_u = absorbance of test sample
- A_s = absorbance of standard phosphorus solution
- C = concentration of standard phosphorus solution
- V_t = total extract volume
- V_a = volume of extract analyzer

Determination of Sodium and Potassium

Sodium and potassium were determined by flame photometry. The instrument, Jaway digital flame photometer was set out according to the manufacturer instruction. It was switched on and allowed about 10 to 15 minutes to equilibrate. Meanwhile standard sodium and potassium solution were prepared separately and diluted in series to contain 10, 8, 6, 4 and 2 pp of Na and K respectively.

After calibrating the instrument, 1ml of each standard was aspirated into it and sprayed over the non-luminous flame. The optical density of the resulting emission from each standard solution was recorded. Before flaming, the appropriate element filter (Na or K) was put in place with the standard measured, the test sample extract measure in time and they were plotted into standard cause which was used to extrapolate the content of each test element and calculated as shown below:

$$\text{Na or K (mg/100g)} = x/1000 \times V_t/V_a \times D \times 100/W$$

Where x is the concentration of the test element from the curve.

Determination of Zinc and Copper

The method described by AOAC (2005) was used for mineral analysis. The sample was ashed at 550°C and the ash boiled with 10 mL of 20% HCl in a beaker and then filtered into a 100 mL standard flask. The minerals (Zinc and Copper) were determined by an atomic absorption spectrometer (Varian 220FS SpectraA, Les Ulis, France). All samples were analyzed in triplicate.

Statistical Analysis

Results obtained were subjected to statistical tests using the Statistical Package for Social Sciences (SPSS).

Results and Discussion

Results

The Result of Mineral Composition of Rice milk

Sample s	Calcium (mg/100g)	Magnesium (mg/100g)	Potassium (mg/100g)	Sodium (mg/100g)	Copper (mg/100g)	Zinc (mg/100g)	Phosphorus (mg/100g)
LRS	10.30 ±1.63	122.70 ± 0.94	126.70 ± 1.25	89.70± 0.99	114.30 ± 2.62	115.30± 2.49	138.00 ±2.94
FRS	92.00± 6.38	75.33± 11.09	121.00 ± 0,00	88.33± 4.99	104.30 ±5.73	45.23±0.77	116.70±2.05

The Result of Vitamin Constituents of Rice milk

Samples	Vitamin A	Vitamin E	Vitamin C
LRS (mg/100g)	0.12± 0.03	0.43± 0.04	1.29± 0.04
FRS (mg/100g)	0.13± 0.03	0.40± 0.02	1.33± 0.04

Key:

LRS- Local rice sample

FRS- Foreign rice sample

Discussion

Mineral Composition

Calcium

Calcium contents for milk sample LRS and FRS were 103 ± 1.63 and 92.00 ± 6.38 of which LRS was higher, it simply implies that local rice is good source of calcium compare to foreign rice. The observation is as a result of various processing of foreign rice such as parboiling, de-hulling, polishing e.t.c. The different processing techniques usually affect the nutritional quality of foods. Kuna *et al* (2018) reported 118mg of calcium content of rice milk and 25mg insoymilk. Calcium is important in blood clotting, muscle contraction, enzyme metabolic processes, bone formation and neurological functions (Olayinka *et al.*, 2012).

Magnesium

Magnesium contents tend to be higher in LRS (122.7mg) compared to FRS (75.33mg). This is as a result of the effect of over processing of rice variety and the post processing methods of rice milk which includes cooking and grinding. Kuna *et al.* (2018) reported 11mg of magnesium in rice milk and 25mg in soymilk. The lower contents of rice milk in their research might base on the cultivar of rice used and the processing methods. Magnesium is a nutrient that the body needs to stay healthy. Magnesium is important for many processes in the body, including regulating muscle and nerve function, blood sugar levels, and blood pressure and making protein, bone, and DNA(NIH,2022).

Potassium and Sodium

The potassium and sodium content of LRS were higher with the quantity as 126.7mg compare to FRS which is recorded as 121mg for potassium and 88.33mg and 89.70mg of sodium for FRS and LRS respectively. However, there is no significant difference between the them which means that both rice samples contain appreciable amount of potassium and sodium depending on their level of processing and most times the variety of rice. Kuna *et al.* (2018) reported 39mg of sodium in rice milk and 51mg in soymilk. The difference in the rice milk is similar to the same reason observed in magnesium contents. Potassium is found naturally in many foods and as a supplement. Its main role in the body is to help maintain normal levels of fluid inside our cells. Sodium, its counterpart, maintains normal

fluid levels outside of cells. Potassium also helps muscles to contract and supports normal blood pressure.

Copper

Milk sample of LRS revealed 114.3mg of copper when evaluated and FRS revealed 104.3mg. This explained the fact that during processing of rice, which is the foreign rice, most trace minerals are lost. The high level of copper in LRS could be due to rice bran and the grain itself which is usually left unpolished. Edukondolu (2019) reported 0.037mg of copper in rice milk in his research. Copper works with iron to help the body form red blood cells. It also helps keep the blood vessels, nerves, immune system, and bones healthy. Copper also aids in iron absorption.

Zinc

Zinc content of LRS increased to 115.3mg while FRS decreased to 45.23mg. This is as a result of unprocessed or under-processed rice (local rice) retains more content of antioxidants compared to foreign rice that are usually highly processed. During this processing, most foods lose or reduce their nutrients and rice is not an exemption. Zinc is a trace mineral needed in the body and yet it is necessary for almost 100 enzymes to carry out vital chemical reactions. It is a major player in the creation of DNA, growth of cells, building proteins, healing damaged tissue, and supporting a healthy immune system.

Phosphorus

Phosphorous content of milk samples ranged from (116.7 to 138 mg/100 g). LRS (138mg) was higher in phosphorus than FRS (116.7mg). Kuna *et al.* (2018) reported 27mg of phosphorus which seems to be lower than this present research as the result of same reason explained in each mineral analysis above. Phosphorus synergizes with calcium, magnesium, manganese, vitamins A, C and D, chlorine and protein in bone formation (Olayinka *et al.*, 2012).

Vitamins Constituents

The results of the vitamin compositions of the milk samples were presented in Table 2.

Vitamin A

Vitamin A content of foreign rice milk sample (FRS) had 0.13mg/100g when compared to the local rice milk sample (FRS) which had 0.12mg/100g. The indication of both rice samples is as a result of their level of processing, it seems highly processed rice tend to increase vitamin A content than under-processed rice (Local rice). Vitamin A is an antioxidant which help in formation and maintenance of teeth, bones, soft tissues, white blood cells, lowers cholesterol, boosts immune system and vision (Onwuka, 2007).

Vitamin C

Vitamin C content of FRS was higher(1.33mg) than that of LRS (1.29mg) The variations may be due to variety and processing technique employed as vitamin C is water soluble and heat labile. Vitamin C is a powerful antioxidant that helps the body form and maintain connective tissues, including bones, blood vessels, and skin (Onwuka, 2007).

Vitamin E

The vitamin E content of the two milk samples were evaluated and it was observed that LRS recorded a higher value of 0.43mg when compared to FRS (0.40mg). This simply implies that even though rice are carbohydrate foods, it still has some levels of fat-soluble vitamins in them which may be initiated from their brains. Rice brans contain vitamins, Vitamin E is an antioxidant that helps keep the immune system strong against viruses and bacteria, helps form red blood cells and widen blood vessels to keep blood from clotting inside them, helps the body use vitamin K and the cells also use vitamin E to interact with each other. Kuna *et al.* (2018) reported 208IU for vitamin A, 0.47mg for vitamin E and 0mg for vitamin C in their research on rice milk when compared to the present study which reported vitamin A, vitamin E and vitamin C contents of rice milk samples as LRS(0.12mg, 0.43mg and 1.29mg) and FRS(0.13mg, 0.40mg and 1.33mg)respectively. However, the differences could be subjected at their various processing methods and cultivar of rice used for the study.

Conclusion

Milk extracted from local rice has proven to be a good source of minerals and vitamins among milk extracted from foreign rice. It is high in essential minerals needed for vitality and healthy body when compared to milk extracted from foreign rice. The result of the mineral and vitamin evaluation further explained that milk extracted from local rice is highly nutritious.

Recommendations

In this study I recommend that the high nutritional composition, minerals and vitamins in milk extracted from local rice can

- Be consumed not only for its appetizing qualities but also for the higher nutritional qualities that can be obtained from it.
- Help to fight diseases and infections invading cells in the body and as well correct some health deficiencies such as poor vision, scurvy, osteoporosis and anemia because of its minerals and vitamins constituents.

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