NUTRITIONAL POTENTIAL OF *COIX LACRYMA-JOBI L.* (ADLAI) AS A CEREAL BASED MILK DRINK

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ABSTRACT

In the recent years, Adlai *has been a focus of the Department of Agriculture – Bureau of Agricultural Research (DA – BAR) in the Philippines in the aspect of research and development because of its versatility and nutritional value.* Adlai *(Coix lacryma-jobi L.) is a grass based cereal crop that is rich in starch, vitamins and minerals. It may be a substitute for rice and corn as a potential staple food in the Philippines. This study aims to utilize* Adlai *as a source of Lactose-free Cereal drink, specifically* ***(1)*** *to evaluate the over-all acceptability of* Adlai *cereal based milk drink using 9-point Hedonic Scale. Also, to* ***(2)*** *determine the proximate analysis and Total Dietary Fiber (TDF) content of* Adlai *cereal based milk drink. Lastly, to* ***(3)*** *determine the product cost of* Adlai *cereal based milk drink.* Adlai *Milk and sweetener were tested for formulation (0, 5%, 10%, 15% and 20%) and were subjected to sensory evaluation. The best formulation based on the sensory evaluation was analyzed at Sentrotek in Mandaluyong City for Proximate Analysis and test for TDF.* Adlai *Milk yielded 13.9g Carbohydrates, 0.02g Ash, 86.1g Moisture, 12g Sugars as Invert and 0.02g TDF per 100ml* Adlai *Milk while protein and fat were 0.0g per 100ml* Adlai *Milk. It is concluded that among the samples, formulation with ratio 20 grams of sugar: 80 ml raw* Adlai *cereal based milk drink was the most acceptable for all the panelists. This formulation showed a significant number of total carbohydrates and energy (kcal). However, there were no detected protein and fat, and a decreased TDF in the milk. Moreover, compared to commercial cereal-based milk drink,* Adlai *cereal based milk drink is cost-efficient.*

Keywords: Adlai*, cereal based milk, Coix Lacryma-Jobi L., Total Dietary Fiber*

INTRODUCTION

Breakfast is an essential meal of the day (Hammons & Rafael, 2014). It is associated with many benefits such as cognitive and physical functions (Adolphus, *et al.*, 2013; Rampersaud, *et al.*, 2005; Hoyland, *et al.*, 2009). Consumption of breakfast can contribute to a BMI of a normal body range (Adolphus, *et al.*, 2013). Longer abrupt fasting period, can result to depletion of glycogen stores overnight due to greater sleep demands during childhood and adolescence compared with adults (Thorleifsdottir, *et al.,* 2002). A continuous supply of energy from glucose is necessary to sustain higher metabolic rate (Magpily & Mercado, 2014). Therefore breakfast intake may possibly be vital in providing sufficient energy for morning. However, breakfast is the most often skipped meal. In fact, there is about 20–30% of children and adolescents that skip breakfast in the world (Deshmukh-Taskar *et al.*, 2010; Corder *et al.,* 2011).

Breakfast can be served hot or cold. Food choices for breakfast can affect the level of energy. Breakfast that comprises a balance of carbohydrates, proteins, and fats give a sustained release of energy, keeping blood sugar levels and delaying hunger indicators for numerous hours (Miller, 2009). The portions of a nutritious breakfast are sensible quantities of a protein-rich food such as Low-Fat milk, yogurt, cheese or peanut butter; a food having complex Carbohydrates like whole-grain cereal, bread, or muffins; a serving of a good source of Vitamin C such as orange, grapefruit, or strawberries; and a small amount of good fat to keep your satiety (Miller, 2009).

Without breakfast, it is difficult to get sufficient fiber, vitamins, and minerals. Breakfasts that are fiber-rich include bran cereal, whole-bran muffins, whole-wheat waffles, fiber-rich cereal bars and cooked cereals like oatmeal, cream of wheat, grits, brown rice, and whole-grain couscous (Miller, 2009).

Cereal products are consumed by a large quantity of the population and create a major contribution to population consumptions of fiber, vitamins and minerals. Cereal

products, specifically, are great contributors for fiber in the diet. The whole grains from processed cereals derived are excellent sources of fiber that provides 10g – 100 g of dietary fiber (JADA, 2007).

People who take their breakfast consume more essential nutrients that are important for a healthy body and way of life (Cho, *et. al.,* 2003). They are likely to be slimmer than those who skip breakfast. Consumption of breakfast contributes to intellectual performance which increases attentiveness and fuels bodily activity. (Rampersaud, *et. al.*, 2005).

Cereal grains have been found to be a key source of dietary nutrients all over the world (Blandino, *et al.*, 2003). Grains account for over half of the food energy of the world, it is also the edible part of grasses, and has excellent keeping qualities prior to milling. Cereals is a dominant food in a grass family, *Poaceae*, is also nutrient dense but not easily grown by farmers. Cereal grain has Aleurone layer surrounding it that consists of starchy endosperm, oil, vitamins and minerals while the fibrous layers of bran is the outermost layer, while germ or the embryo is rich in oil (Nesbitt, 2005).

The intake of cereal crops worldwide is certain because cereal grains are grown in bigger amounts and deliver more energy compared to other kind of crop. Therefore, they are considered as staple crops and also a rich source of carbohydrates. In some particular nations, cereal intake is even more moderate and diverse but still substantial. In the Philippines, cereal crops were found to be the largest portion of every Filipino's diet. The most important cereal crop in the Philippines is rice. It is a staple food for about 70 million Filipinos that contributes 35% to the over-all calorie consumption of its population (Amarga, et al., 2008).

Adlai or *Coix lacryma-jobi* (Job's tears) is a grass based cereal crop. Job's tears have glossy bracts, and are frequently used as beads in jewelries. They have delicate bran and starchy grains. Adlai is grown on a small scale as a food grain in East and Southeast Asia. The grains are consumed fully in soup, or pulverized into flour and consumed as gruel or

cakes. In Nagaland, northeast India and in particular parts of Southeast Asia, Adlai is used for fermenting native beers. And its fruits have a range of conventional medicinal uses, including alleged anticancer properties. Farming is reduced as Adlai is substituted by rice and corn. The period and state of domestication are unidentified. Nevertheless Adlai originated in archaeological spots in northeast India from around 1,000 BC. The wild ancestor, *lacryma-jobi*, is a native from tropical Asia that was thick-shelled. The thin-shelled edible form evolved under domestication. Not like most other cereals, Adlai plants are cultured on a small scale, every so often in backyard home gardens. Each plant bears a big number of tears which mature at different times. These are selected as they mature. (Nesbitt, 2005).

Adlai is a grass crop commonly planted in Asian countries including Taiwan, China and Japan. It has been considered an old-fashioned herbal medicine and nutrient, because of its rich nutritional value and exceptional biological and useful effects on the human body (Wu,*et al.*, 2007). According to the ancient Chinese medical book, Pen-Tsao-Kang-Mu in 1596, Adlai seed was used in China for giving cure for warts, chapped skin, rheumatism and neuralgia, and as an anti-inflammatory or anti-helminthic agent (Wang, *et al.*, 2010).

The Department of Agriculture in the Philippines initiates the potential use of the indigenous crop Adlai as an alternative food crop (2013). As an emerging crop, *Coix lacryma -jobi*, Adlai encountered some conflict among farmers not only with respect to the crop's economic capability, but also on its nutrient quality. In the Cordillera Administrative Region (CAR), Philippines, Adlai is cultivated for food, but majority for wine-making, organic fertilizer and grains for feeds for livestock. In Sagada, Adlai was found to be an alternative source of rice and residents use it as their staple food. Other varieties of Adlai *are* mainly grown for ornamental purposes for making necklaces, rosaries, bracelets and table trays in Kiangan, Ifugao. In Kapangan and Benguet, it is used as roasted coffee and boiled rice. Meanwhile, in Impasug-ong and Malaybalay, Bukidnon, Adlai is grown by the Higaunan tribe and it is used as wine and snacks that was served with camote, gabi and banana (Dela Cruz, 2011).

There are existing studies on Adlai in countries like Japan, China and India which use Adlai not only as food and feed, but also as food additive, pharmaceutical, and cosmetic essentials with many medicinal value. Moreover, agronomic properties of Adlai are widely studied, but it is more focused on agricultural investigations. Merely, a few types of Adlai food products are consumed. Particularly, Adlai milk is a known and common native snack in Taiwan, which is made by cooking in water and is typically mixed with green beans (Coludo & Janairo, 2015).

This study will benefit the college students, most especially adolescents and young adults who do not frequently consume or skip their breakfast. Adlai Milk will be a convenient, ready-to-go lactose-free cereal drink as their substitute for conventional breakfasts mostly by adolescent college students who suffer from short hunger syndrome which can affect their scholastic performance. Also, this study will help people with lactose intolerance who can now consume lactose-free milk with their breakfast.

Breakfast is an often skipped meal that is common especially in young adults due to less free time. Some children are more likely to be apathetic, inattentive, and disruptive. Reduced breakfast energy intake was also associated with higher total daily energy intake and when breakfast is skipped, it can be difficult to properly compensate for it later in the day. The leading reason of people for skipping breakfast is the lack of time for eating, followed by getting up late. In the Philippines, according to a study conducted in Baguio City (2014), the highest reason among students for not having a breakfast is that they do not have time, And people tend to neglect breakfast because of lack of time (Al-hasan, *et al.*, 2014). Ready-to-go cereal milk drinks are in-demand nowadays due to the change of lifestyle of this generation. The utilization of Adlai Milk to be a ready-to-go milk drink may potentially able to settle this problem due to the ease of its consumption and ability to cover the nutritional requirements our body needs.

The study focused on proximate composition and total dietary fiber content of the Adlai Grits and Adlai Milk. This study will focus on the over-all acceptability of the Adlai

Milk. This study is limited to using only Adlai grits. Other parts of the plants are not utilized in this research. Only 50 untrained random panelists were chosen for sensory evaluation. The facilities and equipment used in this study to make Adlai milk were insufficient. Packaging and vitamin analysis are not included in the study. Also, the environment was not controlled. The study also is limited to the shelf-life analysis.

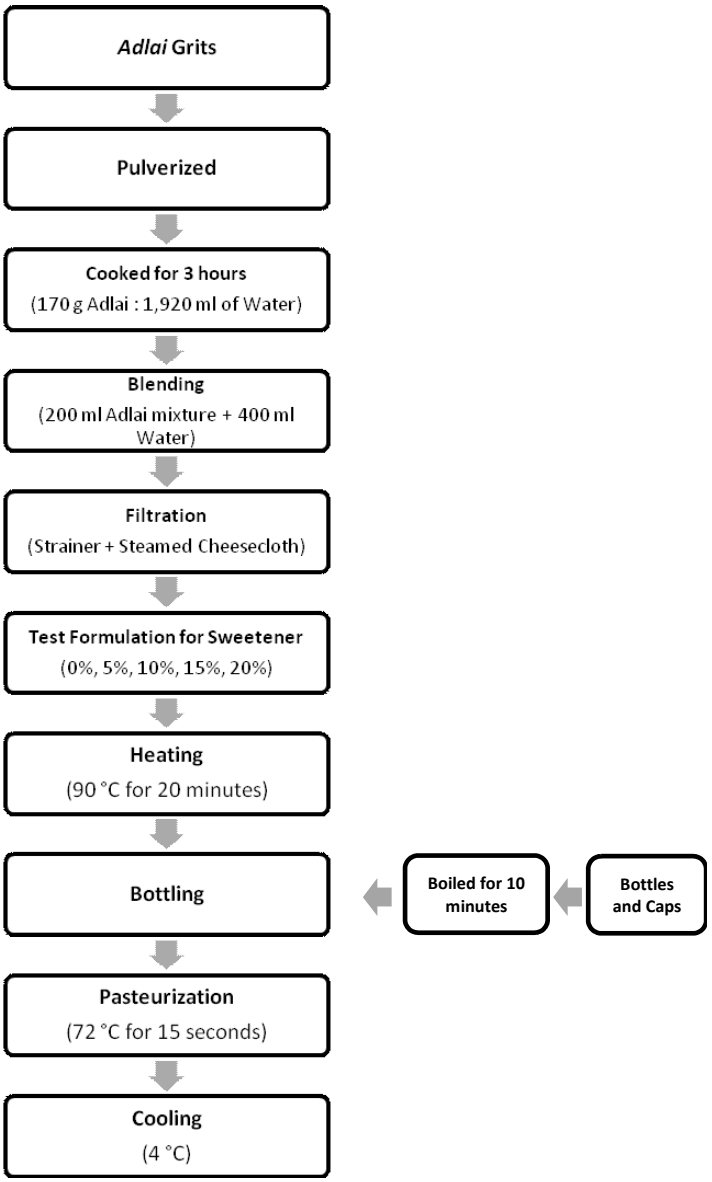

Figure 1. Process of Adlai Milk Production
(based from Belewu et al., 2013; Hassan et al., 2012)

Adlai grits (Gulian variety), refined white sugar, distilled water were the only ingredients that were used in this study. Blender (Magic Bullet model NH21PCS), standard household sifter, cheesecloth, funnel, steamer (American Home model AST-85LS), stock pot, tongs, bottles and caps, gas stove, stainless bowl, sealer, measuring cups and spoons, kitchen scale and digital thermometer (model TP3001) were the tools and equipment used in the experiment.

Experimental Procedures

Preparation of Adlai Grits

Adlai grits – Gulian variety (25 kg) were obtained from the Department of Agriculture in Quezon City Memorial Circle, Philippines. The grits were kept in a room temperature, 27°C. The grits were pulverized using a blender and sifted twice using a standard household sifter.

Production of Adlai Milk

The Adlai Milk was produced according to the procedure by Belewu, *et al.* (2013) and Hassan *et al.* (2012) with some modifications. About eight cups of water were added into one cup of powdered Adlai in a big stockpot and the whole content was placed on heating mantle. The temperature was lower and boiled for three hours and a soupy Adlai pudding was acquired. The mixture was later blended with additional 400 ml water per 200 ml Adlai mixture until a low viscosity and flowing characteristic was obtained (Hassan, *et al.*, 2012). The blended mixture was filtered twice using a steamed cheesecloth and a strainer to have smooth texture

Test Formulation

The milk was subjected to test formulation using 0% (No Sweetener), 5%, 10%, 15% and 20% ratio of sugar as sweetener. The milk formula of beverage per 100 ml amount of serving according to Hassan, *et al* (2012) was modified.

Table 1. Formulation of Samples

Formula for Beverage	Sweetener (%)				
	F1	**F2**	**F3**	**F4**	**F5**
***Adlai* Milk**	100 ml	95 ml	90 ml	85 ml	80 ml
Sugar	0 g	5 g	10 g	15 g	20 g
TOTAL	**100 ml**	**100 ml**	**100 ml**	**100 ml**	**100 ml**
RATIO	**0:00**	**5:95**	**10:90**	**15:85**	**20:80**

**Ratios indicate Sugar: Adlai Milk*

Formulations were subjected to heat at 90 °C for 20 minutes and cooled for 37 °C (Hassan, *et al*., 2012).

Bottling & Pasteurization

The glass bottles were obtained in Synergos Packaging Company in Calle Industria Street, Barangay Bagumbayan, Quezon City. In a pot containing distilled water, enough to cover the bottles, uncapped glass bottles and caps were boiled for 10 minutes (USDA, 2009).The bottles alongside with the cap were cooled. The Adlai milk was placed inside the bottles for 250 ml per bottle. The bottled Adlai milk were pasteurized using a pressure cooker for 72 °C in 15 seconds (Lewis, *et al*, 2008). The temperature was strictly observed using a digital thermometer. The bottled Adlai milk was removed from the container and cooled at room temperature, 27°C. It was placed at the cooler at 4°C (Hassan, *et al*, 2012).

Sensory Evaluation

Fifty random college students of Colegio de San Juan de Letran - Manila were randomly chosen to assess the produced five beverage samples including the control (commercially sold Rice Milk). The six beverage samples were scored according to their color, odor, taste (flavor), texture (smoothness), and over-all acceptability. Scores were based on a hedonic scale of 1 to 9 where: 1 = dislike very much (very bad) and 9 = like very much (excellent) (Hassan, *et al*, 2012 & Lim, 2011). Each panelist was given a palette cleanser (distilled water).

Statistical Analysis

All data collected were subjected to two-way ANOVA (Analysis of Variance) & DMRT (Duncan Multiple Range Test) to determine the significant differences of samples using a level of significance of $p < 0.05$.

Chemical Analyses

The proximate composition of raw Adlai grits (300 grams per sample) and Adlai milk (1 liter per sample) that obtained the highest score in Sensory Evaluation were sent to SentroTek in Mandaluyong City for chemical analyses. SentroTek Corporation is a private Filipino-owned company that was established in the Philippines in December 1999. SentroTek operates a quality management system based on ISO 9002 and ISO/IEC 17025 for the laboratory. Samples were determined by the following parameters; total carbohydrates, ash, moisture, protein, sugar as invert and total dietary fiber. Analytical Methods were based from AOAC official.

Table 2. Adlai Grits per 300 grams & Adlai Milk per 1 Liter sample per Parameter

Parameters	Methodology
Total Carbohydrates	By Computation from Ash, Moisture, Fat and Protein
Ash	Gravimetry (AOAC 923.03, 23.1.05)
Moisture	Gravimetry (AOAC 925.10)
Protein	Kjeldahl (AOAC 991.20, 33.2.11)
Fat	Acid Hydrolysis (AOAC 922.06)
Total Dietary Fiber	Enzymatic-Gravimetry (AOAC 985.29)
Sugar as Invert	Luff Schoorl

Recipe Standardization

Table 3. Standard Recipe for Adlai Milk

Ingredients	Amount
Adlai Grits	170g
Distilled Water	2000ml
Refined White Sugar	200g

Standardized Procedure

Adlai grits (Gulian variety) were pulverized using a blender and sifted using a standard household sifter, twice. The powdered Adlai was measured by 170 grams using a kitchen scale. It was placed in a stock pot together with 1,920 ml distilled water and cooked for 3 hours under a low heat. Constant stirring for 20 minutes is needed to avoid lumps in the mixture.

After 3 hours, 200 ml Adlai mixture was placed in a blender with 400 ml water. It was blended for 2-3 minutes. The blended mixture was then filtered with a cheesecloth. The filtered Adlai milk were combined with 340 grams of refined white sugar and stirred. The produced Adlai milk was subjected to heat for 90 °C in 20 minutes (Hassan, *et al.*, 2012).

For bottling, the uncapped bottles and caps were sterilized in boiling water for 10 minutes (USDA, 2009). After 20 minutes, the heated Adlai milk was measured to 340 ml and poured into the 350 ml bottle. It was capped, sealed and pasteurized for 72 °C for 15 seconds (Lewis, *et al*, 2008). The bottled Adlai milk was stored in 4 °C freezer (Hassan, *et al*, 2012).

RESULTS AND DISCUSSION

Sensory Evaluation

Table 4. Results of Sensory Evaluation and ANOVA

Attributes	Samples					
	824 (Control)	631 (F1)	182 (F2)	211 (F3)	282 (F4)	420 (F5)
Color	5.66^{a}	5.72^{a}	5.76^{a}	6.02^{a}	6.04^{a}	6.08^{a}
Odor	5.54^{a}	4.8^{ac}	5.04^{bc}	5.64^{bc}	6.14^{bd}	6.18^{b}
Taste (Flavor)	4.32^{a}	3.64^{d}	5.08^{e}	6.14^{c}	6.84^{b}	6.86^{b}
Texture (Smoothness)	5.42^{bc}	5.58^{bd}	5.9^{a}	6.54^{b}	6.94^{a}	6.92^{a}
General Acceptability	4.94^{bc}	4.86^{d}	5.8^{a}	6.66^{c}	6.86^{a}	7.04^{a}

**Ratio indicated are as follows (Sugar : Adlai Milk)*
**Same superscript means no significant difference at $p < 0.05$*

Table 4 shows that most of the panelists favored the color, odor and taste (flavor) of the sample 420 (20:80). Moreover, most of them appeared to favor the texture of the sample 282 (15:85). However, the highest among them all in the general acceptability is the sample 420 (20:80), for the reason that it is the most acceptable among the offered samples. Over-all, the highly acceptable was the sample 420 (20:80) followed by sample 282 (15:85), sample 211 (10:90), sample 182 (5:95), sample 824 (control) and sample 631 (0:100), respectively.

Furthermore, based on the results of ANOVA, at 5% level of significance, there is no significant difference in the color among all the samples, while the odor, taste (flavor), texture (smoothness) and general acceptability have a significant difference with the Tabular value (F_T) of 2.21 at 5% level of significance, among the samples.

Figure 3. Sensory Evaluation Results for all of the Samples

In Figure 3, it shows that lowest for the color and texture (smoothness) would be Sample 824 (control) because of the opaque color and suspended solids below. While, the lowest for odor and taste would be Sample 631 (0:100) due to unavailability of sugar in the sample, smell and flavor would not compliment with each other.

In the color, odor, and taste (flavor), the highest scorer would be the Sample 420 (20:80) because most of the panelists like the sweet taste and the color of the milk seems acceptable to them. The highest in texture (smoothness) would be Sample 282 (15:85) because of its flowing characteristic that same as with the milk. The unacceptable among the samples is Sample 631, and the most acceptable among the presented samples is sample 420 (20:80).

Comparison of Adlai Milk Price to Commercially Sold Rice Milk per 1000 ml

Table 5. Comparison of Prices between Adlai Milk (20:80), Brand X and Brand Y

Products	Commercially Sold Rice Milk		
	Adlai Milk (20:80)	**Brand X**	**Brand Y (control)**
Price	Php 83.00	Php 129.00	Php 149.00

As seen in Table 5, Adlai Milk is cheaper than the two Commercially Sold Rice Milk. Compared to Brand X, Adlai Milk is Php 46.00 lower. While compared to Brand Y, Adlai Milk is Php 66.00 cheaper than the said product. Even if not subtracted from the packaging expense of the Brand X and Brand Y, Adlai Milk is still cheaper than the two. The price of Brand X and Brand Y also includes the additives that were included in the production of the two commercially sold rice milk.

Results of Proximate Analysis and Total Dietary Fiber for Raw Adlai Grits and Adlai Milk

Table 6. Proximate Analysis and Total Dietary Fiber of Raw Adlai Grits and Adlai Milk

Parameters	Adlai Grits	Adlai Milk (Gulian variety)
Total Carbohydrates, g/100g	75.3	13.9
Ash, g/100g	0.32	0.02
Moisture, g/100g	9.7	86.1
Protein (N x 6.25), g/100g	13.8	ND
Total Fat, g/100g	0.88	ND
Total Sugars as Invert, g/100g	ND	12
Total Dietary Fiber, g/100g	0.99	0.02

**%Carbohydrates = 100 – (%Moisture + %Ash + %Protein + %Fat)*
**ND means none-detected at the method detection limit of 0.5 g/100g Total Sugars, 0.01 g/100g for Protein and 0.005 g/100mL for Fat*

Table 6 shows that the raw Adlai grits show a significant amount of total carbohydrates and protein, thus, their values respectively are much higher than the values given by the Food Composition Table, 73.3g and 13.1g, respectively. Also, it has a total fat content of 0.88g and Total Dietary Fiber 0.99g. The total dietary fiber is lower than dietary fiber content of 3.7g based on Food Composition Table. Moreover, it does not contain any amount of sugars as invert.

In Table 6, compared to raw Adlai grits, parameters have decreased their values from minimal to none-detection. The Total Carbohydrates and Ash decrease significantly with their values from 75.3g to 13.9g and 0.32g to 0.02g, respectively, when it comes to 100ml of Adlai milk. From the moisture of 9.7g it increases into 86.1g, as evidenced by the water and sugar content of Adlai milk.

Protein and total fat significantly decreased to non-detection of the parameter values. Protein and Fat denature due to the cooking temperature of the powdered Adlai. Above 40 °C, there is an increase in thermal energy that causes protein unfolding or denaturation (Fennema, 1996). Fat losses also increase with the increase in temperature above 70 °C (Sun, 2012). However, due to sugar content of the Adlai milk, Total Sugars greatly increased. there was a great decrease in total dietary fiber content due to the boiling because an increase in temperature leads to a breakage of weak bonds between polysaccharide chains. Also, glycosidic linkages in the dietary fiber polysaccharides may be broken (FAO, 1998).

Comparison of the Nutritional Value of Adlai Milk to commercially sold Rice Milk

Nutrition Facts	
Serving Size 1 cup, 8 floz (240mL)	
Servings Per Container 4	
Amount Per Serving	
Calories 120	Calories from Fat 20
% Daily Value*	
Total Fat 2.5 g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Polyunsaturated Fat 0.5g	
Monounsaturated Fat 1.5g	
Cholesterol 0mg	0%
Sodium 100mg	4%
Total Carbohydrate 23g	8%
Dietary Fiber 0g	0%
Sugars 10g	
Protein 1g	
Vitamin A 10%	Vitamin C 0%
Calcium 30%	Iron 4%
Vitamin D 25%	Vitamin B12 25%
Phosphorus 15%	
*Percent Daily Values are based on a 2,000 calorie diet.	

Figure 4. Nutrition Facts of Commercially sold Rice Milk (Control)

Nutrition Facts	
Serving Size 1 cup, 8 floz (240mL)	
Servings Per Container 4	
Amount Per Serving	
Calories 132	Calories from Fat 0
% Daily Value*	
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Polyunsaturated Fat 0g	
Monounsaturated Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 33g	11%
Dietary Fiber 0g	0%
Sugars 12g	
Protein 0g	
Vitamin A 0%	Vitamin C 0%
Calcium 0%	Iron 0%
Vitamin D 0%	Vitamin B12 0%
Phosphorus 0%	
*Percent Daily Values are based on a 2,000 calorie diet.	

Figure 5. Nutrition Facts of Adlai Milk (20:80)

In these two figures, 4 and 5, respectively, commercially sold rice milk (control) have added Fats, vitamins A, vitamin D, vitamin C, vitamin B12 and minerals such as calcium, iron, phosphorus and sodium just like in the normal milk content, for it to be commercially acceptable when it comes to nutrient value that were based on the 2,000 calorie diet. In addition, protein content of commercially sold rice milk is higher than the *Adlai* milk. However, according to Food Standards Australia New Zealand (2012), some cereal-based beverages are supplemented with added protein that usually comes from a legume source. While, the *Adlai* milk has only its total carbohydrate of 33g and Sugars of 12g higher than the carbohydrate and sugar content of the commercially sold rice milk. Both have 0g dietary fiber due to its heat treatment process used. When it comes to energy yield, *Adlai* milk has the higher calorie content compared to commercially sold rice milk.

CONCLUSION

In the study, it is concluded that among the samples, sample 420 (20:80) with 20 grams of sugar and 80 ml raw Adlai milk was the acceptable for most of the panelists. Sample 420 shows a great number of total carbohydrates and energy (kcal). However, there was no detection of protein and fat due to denaturation caused by the higher cooking temperature of Adlai. Also, there was a decrease in the Total Dietary Fiber of Adlai milk due to boiling of Adlai. Thus, Adlai milk is a great source of total carbohydrate and calorie.

RECOMMENDATION

For future study, researchers recommend that microbiological analyses of the Adlai milk must be done in the future. This is to ensure that the Adlai milk is safe for consumption for an individual. Controlled working environment must be observed. Different Adlai varieties must be tested for the feasibility of utilization of Adlai milk. Several trials must be included to have a reliable data. Different methods for making Adlai milk must be done for comparison. It is also suggested that a bigger number of panelists must be included in the sensory evaluation. Also, Adlai must be purchased ahead of time, but with the assurance that it is of fresh quality. Fortification of Adlai milk with additional protein, fat and added vitamins and minerals, alongside its incorporated flavor must be included in the next phase of this study. Lastly, packaging and vitamin analysis must be included in the future study.

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