World Journal of Dairy & Food Sciences 10 (2): 117-121, 2015
ISSN 1817-308X

DOI: 10.5829/idosi.wjdfs.2015.10.2.9622

Nutritional and Sensory Properties of Almond (*Prunus amygdalu Var. Dulcis)* Seed Milk

Alozie Yetunde E. and Udofia, Ukpong S.

Department of Human Ecology, Nutrition and Dietetics,
Faculty of Agriculture, University of Uyo, Akwa Ibom State, Nigeria

Abstract: Plant milk was produced from almond (*Prunus amygdalu var. dulcis*) seeds and home prepared soy milk served as control. The milk samples were subjected to proximate, mineral and sensory qualities evaluation using standard methods. A difference and preference test was carried out on milk samples for sensory evaluation. Almond milk sample had a characteristic white colour and milk yield was 82.5%. Significant differences ($p<0.05$) were observed in the proximate, mineral and mean sensory scores of milk samples. Almond milk had significantly higher ash and crude fibre contents. It also contained appreciable and significantly higher amounts of calcium (13.1mg/100ml), potassium(65.33mg/100ml), phosphorus(75.2mg/100ml),magnesium (42.05mg/100ml), iron (1.40mg/100ml) and zinc (4.58mg/100ml). Sensory evaluation of the milk samples showed significant differences between samples. Almond milk (1.90) was comparable to soymilk (2.10) in mouth feel ($p>0.05$). However, almond milk was more preferred in terms of colour, flavor, taste and overall acceptability ($p<0.05$). Almond milk is nutrient dense with lower calories than soy and dairy milks. Noteworthy is its nutritional benefits of promoting cardiovascular health and reduction of trace mineral deficiencies especially iron and zinc.

Key words: Plant Milk · Almond Milk · Proximate Composition · Sensory Evaluation · Trace Mineral

INTRODUCTION

The continuous increase in population and inadequate supply of protein has advertently increased the occurrence of malnutrition in developing countries [1]. However, in order to meet the protein demands in developing countries where animal protein is grossly inadequate and relatively expensive, research effort is geared towards finding alternative sources of protein from plant foods [2]. The adequacy of protein in the diet for effective body building and metabolism cannot be overemphasized as it is considered of immense nutritional importance to man and animals. A daily protein intake of 67g is recommended for an average Nigerian of which 58% must be from foods of animal origin which includes milk and its products [3]. Milk has been described as a compulsory part of daily diet for the expectant mothers as well as growing children because of its balance of protein, lactose, fat, non-protein nitrogen and ash [4]. Eneobong [5] described the precarious state of food supply in developing countries including Nigeria and posited that milk and its products are hardly major items of the diets. However, it must be stressed that for the selective few that are able to afford animal milk, there is always an increasing concern about its fat and cholesterol contents. Thus there is a gradual shift from overdependence on animal fat and proteins because of the attendant health implications to that of plant origin that have less incidence of cardiovascular and degenerative diseases [6]. This factor coupled with the huge foreign expenditure on milk importation because of limited supply from local dairy producers favour the development from alternative milk sources from plant materials with functional properties. West Africa is blessed with diverse, readily available and high quality protein and fat sources that are relatively inexpensive.

Plant seeds form an important part of human diets and their significance especially in the diet of the population of developing countries is increasing for several reasons [7]. The seeds are good sources of proteins, edible oils and fats in the diet as well as potential raw materials for local industries [8]. Plant milk is a general

Corresponding Author: Yetunde Alozie, Department of Human Ecology, Nutrition and Dietetics, Faculty of Agriculture, University of Uyo, Akwa Ibom State, Nigeria Tel: +2348039385198.

term for a product that is derived from a plant source that resembles milk but contains neither milk fat nor other important dairy product [9]. The similarity of the functional properties, nutritive value and sensory characteristics of these milk analogues allow them to be used as substitutes for animal milks [10].

Milk from nuts, seeds and grains represent an alternative to animal milk. These alternatives have been characterized by a profile of healthy fatty acids and carbohydrates with low glycaemic index as well as constituents of vitamins B and E, antioxidants (Phytosterols and/or polyphenols) and dietary fibre. They are also rich sources of potassium and low sodium thus promoters of healthy balance of electrolytes as well as good calcium/phosphorus ratio. Development of milk substitutes extracted from plants serves as an alternative source of producing acceptable nutritious drinks. Among the sources of vegetable milk, soybean has received the highest research attention while little attention has been given to bambara groundnut [11], baobab [12], peanut [13], melon seed [14], tigernut [15] and breadfruit [16] but no attention has been given to underutilized seeds such as almond seeds.

Almond (*Prunus amygdalu var. dulcis*) is a common fruit in Nigeria. The outer flesh is commonly eaten by children and the kernel often thrown as waste. It belongs to the family Roseceae and genus, prunus. It is a drupe with a thick leathering grey-green exocarp called the hull. It has been shown to be a nutritious food with a 100 gram serving providing more than 20% of the daily value of riboflavin, niacin, vitamin E, calcium, iron, magnesium, manganese, phosphorus and zinc. The same serving size is also a good source (10-19% RDI) of thiamine, vitamin B6 and folate; choline and the essential mineral potassium. They are also rich in dietary fiber, monounsaturated fats and polyunsaturated fats which potentially may lower LDL cholesterol [17]. Typical of nuts and seeds, almonds also contain phytosterols such as beta-sitosterol, stigmasterol, campesterol, sitostanol and campestanol, which have been associated with cholesterol-lowering properties [17]. The call for food diversification through the promotion and wider application of underutilized indigenous food plants that are traditionally known will add to food security and could be a viable option in ameliorating shortage of protein among the populace in developing countries. The aim of this study is to ascertain the potential of almond fruit seed as a plant milk source and evaluate its chemical and sensory characteristics.

MATERIALS AND METHODS

Sample Collection: The mature ripe almond fruits were obtained by hand picking from trees located in the annex and town campuses of the University of Uyo, Uyo Akwa Ibom State located in South-east Nigeria in February, 2014. Soybean, granulated sugar and vanilla essence were procured from Akpan Andem Market in Uyo Local Government Area.

Sample Preparation: The collected almond fruit was sorted to remove the spoilt and/or infested ones. They were washed, peeled and pulp scrapped off with a knife to obtain the kernel. The kernels were sundried for four days and cracked along the ventral sutures to obtain the nuts. One kilogramme of the nuts was dehulled after soaking in hot water then rubbing off the skin between fingers. Milk was extracted from the dehulled nuts by soaking in deionized water at 4°C for six hours after which it was drained, rinsed and wet milled in a kitchen blender (Kenwood, England) using maximum speed with nuts to water ratio as 1:3 (w/v) for five minutes. The resultant slurry was strained through a double layered cheese cloth. 200ml sugar syrup (Made by boiling and cooling 200g of granulated sugar in 50ml water) was added to the filtrate which was homogenized and pasteurized at 121°C for fifteen minutes. The milk extract was flavoured with 15ml vanilla essence prior to bottling in sterilized screw capped plastic bottles and stored at 4°C. The control vegetable milk sample, soybean milk was processed using the Illinois method described by Iwe [18].

Chemical Analysis: The plant milk samples was analysed for proximate composition using standard methods described by AOAC [19]. Mineral analysis was carried out using the dry ashing method. Calcium, iron, magnesium and zinc were determined using absorption spectrophotometry, potassium and sodium by flame photometry and phosphorus by molybdovanadate method.

Sensory Evaluation: Sensory evaluation was conducted in two stages. The first stage was conduction of a difference test. Triangle test described by Iwe [20] was used. Twenty panelists consisting of staff and final year students of the Department of Human Ecology, Nutrition and Dietetics, University of Uyo were divided into two groups (A and B). The samples were three digit coded. Group A was presented with two almond milk samples and one sample of soymilk while group B were presented two samples of soymilk and one of almond milk in a randomized manner and were asked to identify the odd sample as well as indicated degree of difference and the more acceptable sample. The second stage was a consumer preference test which involved the presentation of the two vegetable milk samples that were three digit coded to a panel of twenty members who were familiar with plant milk products and rated the products on a nine point hedonic scale where 1=Excellent, 5= neither like nor dislike and 9=Very poor for parameters of colour, taste, mouth-feel, flavor and overall acceptability.

Statistical Analysis: Data on proximate and mineral analyses were presented as mean of triplicate analyses while mean of sensory scores for each attribute was based on twenty judgments and subjected to Student's t- test. Means were considered significant at probability level of 5%.

RESULTS AND DISCUSSIONS

Proximate Composition: The result of the proximate composition of milk samples is shown in table 1. Significant differences were observed between the samples in all parameters evaluated with exception of moisture and crude fat contents. Almond milk showed significantly higher values of ash, crude fibre and carbohydrate contents. Moisture level obtained in this study for both samples were similar to values reported for melon seed milk (88.0%) and cow milk (87.10%) [21]. Concentration of other nutrients and specific gravity of milk samples is affected by moisture level [21]. The protein content of soymilk was significantly higher than that of almond milk. Protein value obtained for almond milk in this study (1.70%) was lower than value reported for melon seed milk (3.67%) reported by Akubor [14] and benniseed milk (2.86%) [22]. It was also lower than values of protein in dairy milk (3.30 and 3.50%) [21, 23]. It is however noteworthy that protein content of almond milk (1.70%) obtained in this study was higher than value reported for melon seed milk (1.30%) [21]. Generally, the composition and balance of amino acid of milk samples is of greater importance than quantity of protein. The amount of fat in almond milk (3.40%) met the minimum requirement level of 3% specified by Codex Alimentarius [23] and was similar ($p>0.05$) to value obtained for soymilk (3.2%) in this study. The total ash content of almond milk was higher than values reported for dairy milk (0.70%), melon seed milk (1.62%) and *Treculia africana* seed milk (0.89-0.96%) [14, 16, 21]. The higher ash content of samples in this study in comparison with dairy milk is suggestive of the richness of the samples as micronutrient sources. Noteworthy is the crude fibre content of the almond milk which was significantly higher than value obtained for soymilk and an advantage over dairy milk as it will aid stomach motility. The carbohydrate content of milk samples in this study were lower than the values reported for dairy milk (5.0%), human milk (6.8%) and melon seed milk (5.90%) [16, 21]. Energy values obtained for the milk samples in this study were lower than cow's milk (68.3kcal).The energy value for almond milk (55.4kcal) was lower ($p>0.05$) than that for soybean milk (57.36kcal). Fat and carbohydrates are the major energy sources in a given food sample. Thus the contribution of these components to the energy value of almond milk (48.6kcal) is similar to value obtained for the same components in melon seed milk (50.97kcal) and are sufficient as energy sources thus producing a protein sparing effect [21].

Mineral Composition: The mineral composition of the milk samples is shown in table 2. Results showed significant differences between the milk samples in all mineral assayed. The values obtained for almond milk were generally higher ($p<0.05$) except for sodium. The variation in the mineral composition of the milk samples is a reflection of their ash content which was significantly higher in almond milk. Mineral composition of plant milk samples have been reported to vary with the level of minerals in the seed of extraction, extraction method, seed/extractant ratio among others [16. Almond milk sample contained appreciable amounts of calcium, magnesium, potassium and phosphorus. Almond milk has been reported to lessen resistance of veins and arteries resulting in better flow of blood, oxygen and nutrients due to the presence of these natural minerals [24]. The observed level is expected as almond seeds have been reported to be rich sources of these minerals [25]. The high potassium low sodium content of almond milk is a plus in the promotion of cardiovascular health making almond milk an especially good choice in protecting against high blood pressure and atherosclerosis. The amount of trace minerals, iron and zinc in almond milk samples is appreciably high. Values obtained for iron (1.40mg/100ml) was higher than values for soy milk (0.58mg/100ml) and the previously reported values for soymilk (0.56mg/100ml) [9] African breadfruit (0.40-0.52mg/100ml) [16] and dairy milk (0.1-0.3mg/100ml) [23].

Table 1: Proximate composition of plant milk samples (g/100ml)

Parameters	Soymilk	Almond Milk
Moisture	88.12 ± 0.20a	86.11 ± 0.3a
Protein	2.36 ± 0.24a	1.70 ± 0.20b
Fat	3.20 ± 0.15a	3.40 ± 0.18a
Ash	0.84 ± 0.10b	3.04 ± 0.05a
Fibre	0.70 ± 0.04b	1.25 ± 0.10a
Carbohydrate	4.78 ± 0.14a	4.50 ±0.20a
Energy value(Kcal)	57.36 ± 0.22a	55.40 ± 0.45a

Mean of ten samples± SD *Values with different alphabets following along the same row is significantly different at p<0.05

Table 2: Mineral composition of plant milk samples (mg/100ml)

Parameters	Soymilk	Almond Milk
Calcium	3.90± 0.02b	13.10 ± 0.05a
Phosphorus	49.00 ± 0.14b	75.20 ± 0.13a
Magnesium	30.00 ± 0.10b	42.05 ± 0.10a
Potassium	50.00 ± 0.15b	65.33 ± 0.03a
Sodium	25.00 ± 0.20b	6.38 ± 0.00a
Iron	0.58 ± 0.12b	1.40 ±0.05a
Zinc	0.70 ± 0.17b	4.58 ± 0.10a

Mean of ten samples± SD *Values with different alphabets following along the same row is significantly different at p<0.05

Table 3: Sensory qualities of plant milk samples

Parameters	Soymilk	Almond Milk
Colour	3.25± 1.48b	2.15 ± 0.50a
Mouthfeel	2.10 ± 0.24a	1.90 ± 0.23a
Flavour	3.90 ± 0.64b	2.50 ± 0.05a
Taste	3.00 ± 1.89b	2.10 ± 0.08a
Overall Acceptability	3.20 ± 0.20b	1.70 ± 0.15a

Mean ± SD *Values with different alphabets following along the same row is significantly different at p<0.05

The zinc value (4.58mg/100ml) was also higher than values reported by authors for plant milk such as *Treculia africana* (0.32-0.42mg/100ml), soy bean milk (0.7mg/100ml), melon seed milk (0.38mg/100ml) and African yam bean milk (3.25mg/100ml) [16, 21, 22].The level of zinc obtained in this study for almond milk suggests that its consumption will contribute greatly to the reduction of "Hidden hunger" in the developing world including Nigeria where 27.5% and 26% of under-fives suffer from varying degrees of iron and zinc deficiencies respectively as a result of prevalence of infectious and parasitic diseases [26].

Sensory Qualities: Result of difference test conducted using triangle test indicated significant difference between the samples as thirteen of the judges were able to correctly identify the odd sample where a minimum of eleven correct answers was needed to establish significance at 5% [20]. The degree of difference (mean of panelists scores) indicated by the thirteen judges who correctly identified the odd sample when calculated on a four point scale (where slight =1, moderate=2, much=3 and extreme=4) was 1.2 which is equivalent to slight [27]. The triangle test revealed that the odd sample was more acceptable as eleven out the thirteen judges who were able to identify correctly the odd sample found the almond milk sample more acceptable ($p<0.05$) [27].The mean sensory scores of milk samples for preference test on a nine point hedonic scale are presented in table 3. The result indicated significant differences between samples. Milk samples were comparable in mean sensory scores for mouth-feel. The similarity in mouth feel may be attributed to the fat content of the samples which were similar as fat is known to be associated with good mouth feel. Mean sensory scores were however significantly higher for almond milk samples in colour, flavor, taste and overall acceptability as values were closer to 1(Excellent). However milk samples in this study were both acceptable as mean sensory scores for all attributes were below the average score of 5.0.

CONCLUSION

Almond milk is nutrient dense if compared to other plant milks such as soybean. Its high content of fibre and potassium is essential for gastrointestinal and cardiovascular health. Its high level of trace minerals especially iron and zinc is of great nutritional significance especially in the developing world where iron and zinc deficiencies are high and the fact that dairy milk has relatively low levels of these minerals.

REFERENCES

1. Siddhuraju, P., K. Vijayakumari and K. Janardhanan, 1996. Chemical composition and protein quality of little-known le gume, velvet beans (Mucuna pruriens (L) DC). J. Agric. Food Chem., 44: 2636-2641.
2. Nsofor, L.M. and O. Maduko, 1992. Stabilized soymilk for ambient tropical storage: A preliminary report. International Journal of Food Science and Technology, 27: 573-576.
3. FAO, 1991. Guidelines for Slaughtering, Meat Cutting and further Processing. FAO Animal Production and health paper No. 91, pp: 170.

4. Sisay, M., T. Feyera and O. Mohammed, 2015. Microbiological Quality of Raw Cow's Milk from Four Dairy Farms in Dire Dawa City, Eastern Ethiopia. World Journal of Dairy & Food Sciences, 10(1): 09-14.
5. Eneobong, H.N., 2001 Eating Right: A Nutrition Guide. University of Calabar Press, pp: 87-89.
6. Gaman, P.M. and K.B. Sherrington, 2001. The Science of Food. Jones and Barlett Publishers.
7. Brain, F.A. and G.C. Alan, 1992. Food Science, Nutrition and Health. Edward Arnold, pp: 17-20.
8. Christian, A., 2007. Fluted pumpkin (Telfairia occidentalis Hook F.) seed: a nutritional assessment. Electronic Journal of Environmental, Agricultural and Food Chem., 6(2): 1787-1793.
9. Potter, N.N. and J.H. Hotchkiss, 1995. Food Science. Fifth Edition. Chapman and Hall, pp: 315.
10. Enwere, N.J., 1998. Foodsof Plant Origin. Afro-Orbis Publications Ltd, pp: 215-227.
11. Obizoba, I.C. and H.I. Egbunna, 1992. Effect of germination and fermentation on nutritional quality of Bambara nut (Voandzei subterranean Thourars) and its products (milk). Plant Foods for Human Nutrition, 42: 13-23.
12. Obizoba, I.C. and J.U. Anyika, 1994. Nutritive value of Baobab milk (Adansonia digitala L), Hungary rice, Acha (Digitania exillis) flours. Plant Foods for Human Nutr., 46: 156-165.
13. Odo, F.O., 2001. Consumer acceptance of groundnut milk. In the Proceedings of the 25th Annual Conference of the Nigerian Institute of Food Science and Technology (NIFST), pp: 135-137.
14. Akubor, P.I., 1998. Physicochemical and sensory characteristics of melon seed milk. J. Food Sci. Tech., 35: 93-95.
15. Ukwuru, M.U., L.J. Omachona and N. Onokah, 2008. Production and quality assessment of tigernut (Cyperus esculentus) imitation milk during storage. J. Food Sci. Technol., 45: 180-182.
16. Onweluzo, J.C. and C. Nwakalor, 2009. Development and evaluation of vegetable milk from Treculia africana (Decne) seeds. Pakistan J. Nutr., 8(3): 233-238.
17. Berryman, C.E., A.G. Preston, W. Karmally, R.J. Deckdelbaum and P. M. Kris-Etherton, 2011. Effects of almond consumption on the reduction of LDL-cholesterol: a discussion of potential mechanisms and future research directions". Nutrition Reviews, 69(4): 171-85.
18. Iwe, M.O., 2003. The science and technology of soybean. Rojoint Communication Services Ltd, pp: 145.
19. AOAC., 2010. Official Methods of Analysis. 18th Edition. Association of Official Analytical Chemists, Washington DC.
20. Iwe, M.O., 2010. Handbook of Sensory Methods and Analysis. 2nd Edition. Rojoint Communication Services Ltd, pp: 20-58.
21. Omole, J.O. and O.M. Ighodaro, 2012. Proximate composition and quality attributes of milk substitute from melon seeds (Citrulus vulgaris schrad). Rep. Opinion, 4(9): 75-78.
22. Nnam, N.N., 2003. Nutrient composition and acceptability of vegetable milks from oilseeds. J. Home Economics Research, 5: 57-61.
23. Passmore, R. and W.A. Eastwood, 1986. Human Nutrition and Dietetics. 8th Edition. Churchhill Living stone, pp: 235-240.
24. Ensminger, A.H. and M.K. Ensminger, 1999. Food for Health: A Nutritional Encyclopedia. Pegus Press.
25. Kirbaslar, F.G., G. Turker, Z. Ozsoy-Gunes, M. Unal, B. Dulger, E. Ertas and B. Kizilkaya, 2012. Evaluation of fatty acid composition, antioxidant and antimicrobial activity,mineral composition and caloric values of some nuts and seeds from turkey. Rec. Nat. Prod., 6(4): 339-349.
26. Aminu, F.T., 2010. Reducing micronutrients malnutrition in Nigeria: A review of policy and programmatic options for improving children's and women's health. In the Proceedings of the 41st Annual Conference and Scientific Meeting of Nutrition Society of Nigeria, pp: 4-18.
27. Ihekeronye, A.I. and P.O. Ngoddy, 1985. Integrated Food Science and Technology for the Tropics. Macmillian Publishers, pp: 172-190.