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Research Article

# Influence of Processing Treatments on Quality of Vegetable Milk from Almond (*Terminalia catappa*) Kernels

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## Abstract

The effect of different processing treatments on some quality characteristics of the vegetable milk from almond (*Cyperus esculentus*) kernels was determined. Raw almond kernels were divided into two lots. One lot was sub divided into two groups and subjected to processing treatments that included steam blanching (85°C for 5, 15 and 30 minutes) and hot water blanching (85°C for 5, 15 and 30 minutes) and later made into milk respectively. The other lot was not treated, made into extract and divided into two groups. One group was pasteurized at 72oC for 15minutes and the other was left untreated (control). The almond products were subjected to physical, chemical, microbiological and sensory analyses using standard analytical methods. The yield, pH, total solids and total titratable acidity ranged from 53.60 - 56.26%, 6.53 - 6.93, 4.19 - 6.24% and 0.09 - 0.15% respectively. The proximate composition of almond milk samples ranged between 0.7 - 1.6% protein, 1.6 - 2.3% fat, 0.12 - 0.29% ash, 0.11 - 0.28% fiber, 0.33 - 2.77% carbohydrate and 20.59 - 27.03 kcal/g energy value. The mineral composition (Ca, K, Mg and P) of the milk samples were significantly different ($p \leq 0.05$) with values ranging from 8.62 - 20.00 mg/100g, 220.71 - 303.89 mg/100g, 104.07 - 165.85 mg/100g and 279.73 to 408.82 mg/100g, respectively. The total viable cell count ranged from $1.4 \times 10^3$-$2.3 \times 10^3$ CFU/mL, while yeast and mould count ranged from $0.3 \times 10^2$ to $1.2 \times 10^2$ CFU/mL. No growth occurred in pasteurized sample, thus it was microbiologically safer than other treatments. Though all the soy milk products were acceptable, milk processed from steam blanched nuts for 30 minutes had the highest acceptability score.

**Keywords:** Almond; Blanching; Pasteurization; Milk Quality

## Introduction

Globally, oil seeds are increasingly becoming important in nutrition because they contain substantial quantities of edible oils with appreciable quantities of protein and mineral elements. In developing countries where the supply of animal protein is insufficient to meet the ever-growing population growth, there is increased need to utilize some of the oil seeds in bridging the gap on demand. Research programs on oils have not only identified many plant species presently used vegetable oils (soybean, cottonseed, peanut and corn), but new or unusual kinds oils that will not only compete with the presently used vegetable oils but also those with high industrial promise [1]. The tropical Almond (*Terminalia catappa*) is one of the unexploited oil seeds in Nigeria.

Almond originated from tropical Asia, India and Taiwan though it thrives in other tropical regions of the world including Nigeria ecosystem [2]. The world production of almond fruits stands at 0.7 million tonnes and Nigeria produces 0.1 million tonnes annually [3]. There are several species of the *T. catappa* but the most common is Prunus *amygdalus* which has two types viz: *Prunus delcis vardulas* (sweet variety) and *Prunus var mara* (bitter variety). The sweet almond variety do not contain amygdalin and are widely used as edible kernels and food ingredients while bitter almond is grown for its oil used as flavouring after elimination of amygdalin, an enzyme, which causes its hydrolysis to glucose, benzaldehyde and hydrocyanic acid [4]. Almond contains proteins rich in essential amino acids (22 - 25%), lipids (35 - 52%) mainly unsaturated fatty acids, and minerals among which the most important are potassium, calcium and magnesium [5].

Based on the identified nutritional facts, almond kernels has been utilized in imitated dairy products and they are widely present in the European market as alternatives to cow's milk, being particularly useful for people with problems of lactose intolerance or with allergy to the proteins of cow's milk as well as for vegetarians. The approach was ideal as ever-increasing demand for cow milk has prompted the need to extend search for its substitute not only in other mammals but also from plant source. Besides such classical uses, these vegetable milks have been promoted as healthy foods, mainly as protectors against cancer and cardiovascular diseases [6]. This is due since they allow the saturated fatty acids of animal milk to be substituted by the unsaturated fatty acids of plant products. Moreover, they contain other beneficial bioactive compounds: antioxidants such as flavonoids, vitamin E, fibre and phytosterols, which reduce cholesterol absorption. However, it is worrisome that industrial processing of almond kernels into milk has not developed in Nigeria though almond trees are commonly found in the Southern and South-Western rain forest zones of the country. The country is yet to maximize the potential of vegetable milk as a replacement for cow milk as a cheap source of high quality proteins.

Several processes have been adopted in the production of vegetable milk. Thermal processing of milk is an essential step aimed at improving the quality and storability of the fluid. However, in modern welfare societies, the concepts of quality, safety and health have acquired importance in several fields, particularly in nutrition. In essence, these three aspects though complex are involved in the definition and evaluation of a food. Consequently, the challenge to the food processing industry is to minimize the loss of nutrients during thermal processing, retain nutraceutical components and at the same time provide an adequate process to destroy the spores usually common in vegetable milk as part of its microbiota. This research was designed to investigate the interaction effect between pre-treatments of almond nut with steam blanching and hot water blanching respectively prior to milk extraction; and pasteurization of the milk.

## Materials and Methods

### Procurement of raw materials

Dry matured fruits of almond (*Terminalia catappa*) were obtained from a local market in Ogbomosho, Nigeria and transported in sacks. The fruits were decorticated using a piece of pebble to obtain the brown-spindle shaped kernels.

### Preparation of almond milk

The decorticated almond kernels were divided into four batches. One batch was filled in sieve and put over steam bath maintained at 85°C for 5 - 30 minutes then cooled directly by immersing in cold water. The second batch was filled in sieve and immersed in hot water bath maintained at 85°C for 5 - 30 minutes, then cooled directly by immersing in cold water. Treated almond kernels (from the two batches) and water were weighed (1:6) to give the desired almond percentage respectively. The kernels were then transferred to the blender vessel and a small portion of the weighed water was added to facilitate the progress of mixing/grinding process. The blender was operated at highest speed for 10 minutes. After finishing the grinding process, the remaining quantity of water was added and mixed thoroughly. The resulted almond dispersion was homogenized (in portions of 300g) for 5 minutes using lab homogenizer. The homogenized almond milk base was squeezed through cheesecloth to separate coarse particles. The resulted milky solution was weighed, readjusted to its original weight (before filtration) by adding water, sweetened by the addition of 5% sugar syrup, mixed thoroughly and stored in pre-sterilized glass bottles. The third batch was not treated but soaked, crushed and pressed. The resultant milk was pasteurized at 72oC for 15minutes. For pasteurization, almond milk sweetened with 5% sugar syrup was filled in a beaker and heated in boiling water bath with manual stirring. The pasteurized milk was then filled into pre-sterilized glass bottles and cooled by immersing the bottles in ice bath for 5 minutes. The other batch was cleaned, soaked, crushed, pressed and sweetened by the addition of 5% sugar syrup. No heat treatment was given to the almond nuts before and after processing into milk and served as the control.

### Determination of physical characteristics

The physical characteristics of various milk samples were determined shortly after they were brought to the laboratory. The yield of almond milk was determined as a percentage of the weight of the extract to the original weight of the nuts. Titratable acidity, pH and total solids were determined according to standard methods [7].

### Chemical analysis

Moisture, protein, fat, fiber and ash contents were determined by reference AOAC method [7]. Carbohydrates were determined by difference calculation. The energy value was estimated (kcal/g) by multiplying the percentage crude protein, crude lipid and carbohydrate by the recommended factor (2.44, 8.37 and 3.57 respectively) as described by Ekanayake., *et al* [8].

For minerals analysis, the milk solid contents were taken and digested using two volumes of concentrated nitric acid. After adding one volume of perchloric acid, the contents were heated gently on a hot plate followed by a vigorous heating till dryness (approximately 1~2 ml). This digestion technique makes no attempt to dissolve any silicate-based material that may be present in the samples. After cooling, the digested samples were quantitatively transferred to a flask and diluted to 100 ml with deionized double distilled water and then filtered. Atomic absorption spectrophotometer (A. Analyst 700, Perkin Elmer, USA) equipped with standard burner, air-acetylene flame and hollow cathode lamps, as radiation source, was used for the analysis of calcium and magnesium. Flame photometer (JENWAY PFP7) was used to determine the concentration of potassium. Colorimetric method involving Phospho vanado molybdate (yellow) was used to quantify the phosphorous present in the sample.

### Microbiological analysis

Decimal dilutions in peptone water solution were for microbial enumeration. Microbial analysis of almond milk was determined using different mediums. Total viable count (TVC) and total yeast and mould count were estimated using the pour plate method as described by Frazier and Westhoff [9]. Serial dilutions of the samples were poured into plate count agar and incubated at 37 ± 2°C for 48h after which the total viable colonies on the plate were counted. For yeast and moulds, malt extract agar was used, and the plates were incubated at 25 ± 3°C for 3 days. The plates were counted using colony counter.

### Sensory evaluation

Eight samples of almond milk were assessed for sensory characteristics using 25-member semi-trained panellists selected on the basis of their familiarity with soy milk. The samples were coded and presented to the panellists using white glass cups and water was provided for mouth wash in between evaluations. Panellists were asked to evaluate the samples for colour, flavour, taste, mouth feel and overall acceptability using a 5-point Hedonic Scale (5 = like extremely and 1 = dislike extremely).

### Statistical analysis

Determinations were carried out in triplicates and the error reported as standard deviation from the mean. Analysis of Variance (ANOVA) was performed and the least significant differences were calculated with the SPSS software for window release 16.00; SPSS Inc., Chicago IL, USA. Significance was accepted at $p \leq 0.05$ levels.

## Results and Discussion

### Effect of pre-treatment of almond kernels and heat treatment of almond milk on the physical characteristics the produced milk

The data pertaining to the physical characteristics of almond milk is presented in table 1. The average percentage yield of milk samples ranged between 53.60 and 56.26%. The control sample had highest yield (56.26%) and was significantly different ($p \leq 0.05$) from other samples. The result indicated that the various treatments employed in the production process might have influenced the percentage yield. The lower yield reported for treated samples might be due to the heat applied possibly by causing the gelatinisation of starches. Gaspar., *et al.* [10] reported that the high concentration of starch causes gelation to readily occur, especially when heat treatments (beyond 72$^{0}$C) are employed during processing.

The concentration range of total solids was from 4.19% to 6.24%. Sample G had the lowest amount of total solids (4.19%) followed by sample C (4.24%) and the highest was found in the control sample (6.24%). Pre-treatment of almond kernels over time prior to extraction of the milk and pasteurization of almond milk resulted in significant reduction in total solids compared to the control. The nature of processing of such samples might have influenced the extractability of less almond solids. Johnson and Snyder [11] noted that heating of soybean before grinding partially coagulates protein and keeps the protein bodies intact which in turn results in retention of more solids on the screen. Similarly, there was a significant decrease in total solids content with the increase in pressure blanching time of peanut milk [12].

| Sample | Yield (%) | Total solids (%) | pH | Titratable acidity (% lactic acid) |
|---|---|---|---|---|
| A | 54.95$^{g}$± 0.02 | 4.80$^{e}$ ± 0.01 | 6.67$^{d}$ ± 0.06 | 0.12$^{b}$ ± 0.01 |
| B | 54.64$^{e}$± 0.02 | 4.54$^{c}$ ± 0.02 | 6.59$^{b}$ ± 0.01 | 0.14$^{be}$ ± 0.01 |
| C | 54.56$^{c}$± 0.05 | 4.24$^{b}$ ± 0.01 | 6.67$^{d}$ ± 0.03 | 0.09$^{a}$ ± 0.01 |
| D | 54.72$^{f}$ ± 0.01 | 5.79$^{g}$ ± 0.03 | 6.63$^{cd}$ ± 0.02 | 0.15$^{bc}$ ± 0.01 |
| E | 54.60$^{d}$ ± 0.02 | 5.28$^{f}$ ± 0.01 | 6.61$^{c}$ ± 0.02 | 0.09$^{a}$ ± 0.01 |
| F | 54.18$^{b}$ ± 0.02 | 5.69$^{d}$ ± 0.02 | 6.70$^{e}$ ± 0.02 | 0.09$^{a}$ ± 0.01 |
| G | 53.60$^{a}$ ± 0.02 | 4.19$^{a}$ ± 0.01 | 6.53$^{a}$ ± 0.02 | 0.13$^{b}$ ± 0.01 |
| H | 56.26$^{h}$ ± 0.02 | 6.24$^{h}$ ± 0.04 | 6.93$^{f}$ ± 0.02 | 0.08$^{a}$ ± 0.01 |

**Table 1:** Yield, pH, Total Solid and Titratable Acidity of Almond Milk

Values are mean of three determinations ± standard deviation (n = 3). Values with different subscript within the same row are significantly different from each other

A- Almond milk prepared from steam blanched (5 minutes) almond nuts; B-almond milk prepared from steam blanched (15 minutes) almond nuts; C- almond milk prepared from steam blanched (30 minutes) almond nuts; D-almond milk prepared from hot water blanched (5 minutes) almond nuts; E- almond milk prepared from hot water blanched (15 minutes) almond nuts; F-almond milk prepared from water blanched (30 minutes) almond nuts; G- pasteurized almond milk from almond nuts; H- untreated almond milk from almond nuts.

The pH of all the milk samples was however close to neutrality immediately after preparation with slight variations. The values were comparable to the pH of melon seed milk [13], cowpea milk [14] and soymilk [15]. Total titratable acidity ranged between 0.08 and 0.15% for the milk samples. Earlier work reported by Ade-Omowaye., *et al.* [16] on the quality evaluation of beverage produced from pre-treated tigernut (*Cyperus esculentus*) showed that titratable acidity ranged between 0.22 and 0.27%. Milk acidity measured as pH or titratable acidity is very important property. Whereas pH is a direct measure of H+ activity, titratable acidity is a measure of buffering capacity between its own pH and that of the colour change (from colourless to red) in phenolphthalein. The exact pH value is influenced by protein, mineral and acid contents of milk sample. The pH of milk may influence many other aspects related to quality, in particular, the colloidal stability of milk and other heat-induced reactions, such as Maillard browning [17]. It is also important to note that both microbial activity and microbial inactivation are also influenced by pH, as is enzyme activity. The fact that all the pH values are below neutral (7.0) is an indication that microbial growth will not be encouraged in the almond milk samples.

### Effect of pre-treatment of almond kernels and heat treatment of almond milk on the chemical composition of the produced milk

The milk samples were also subjected to various chemical analyses and the results were as presented in table 2. Chemical characteristics of samples showed considerable variations and each sample excelled over other in one or other aspect. Almond milk prepared from steam blanched (30 minutes) almond nuts (sample C) had highest moisture value (95.81%) which was significantly different from the control (93.76%) and the remaining samples. Similarly, steam blanching for 30 minutes increased the moisture in resultant milk sample, in comparison with the control, with an

| Sample | Moisture (%) | Protein (%) | Fat (%) | Ash (%) | Fiber (%) | Carbohydrate (%) | Energy (kcal/g) |
|---|---|---|---|---|---|---|---|
| A | 95.20$^{d}$ ± 0.15 | 1.21$^{f}$ ± 0.01 | 1.62$^{a}$ ± 0.02 | 0.17$^{b}$ ± 0.01 | 0.16$^{bc}$ ± 0.01 | 1.63$^{e}$ ± 0.01 | 22.33$^{b}$ |
| B | 95.46$^{f}$ ± 0.10 | 1.15$^{e}$ ± 0.01 | 1.95$^{c}$ ± 0.01 | 0.15$^{b}$ ± 0.01 | 0.18$^{c}$ ± 0.01 | 1.11$^{b}$ ± 0.07 | 23.09$^{c}$ |
| C | 95.81$^{g}$ ± 0.12 | 1.12$^{d}$ ± 0.01 | 2.32$^{e}$ ± 0.01 | 0.20$^{c}$ ± 0.01 | 0.22$^{d}$ ± 0.01 | 0.33$^{a}$ ± 0.01 | 23.33$^{d}$ |
| D | 94.21$^{b}$ ± 0.10 | 1.14$^{e}$ ± 0.01 | 1.78$^{b}$ ± 0.01 | 0.12$^{a}$ ± 0.01 | 0.13$^{a}$ ± 0.01 | 2.62$^{g}$ ± 0.01 | 27.03$^{g}$ |
| E | 94.72$^{c}$ ± 0.16 | 0.82$^{c}$ ± 0.01 | 1.77$^{b}$ ± 0.02 | 0.16$^{b}$ ± 0.01 | 0.11$^{a}$ ± 0.01 | 2.41$^{f}$ ± 0.01 | 25.42$^{f}$ |
| F | 95.31$^{e}$ ± 0.16 | 0.78$^{b}$ ± 0.01 | 2.09$^{d}$ ± 0.02 | 0.19$^{c}$ ± 0.01 | 0.15$^{b}$ ± 0.01 | 1.48$^{d}$ ± 0.01 | 24.68$^{e}$ |
| G | 93.71$^{a}$ ± 0.10 | 0.69$^{a}$ ± 0.01 | 1.76$^{b}$ ± 0.01 | 0.29$^{d}$ ± 0.01 | 0.28$^{e}$ ± 0.01 | 1.17$^{c}$ ± 0.01 | 20.59$^{a}$ |
| H | 93.76$^{a}$ ± 0.10 | 1.62$^{g}$ ± 0.01 | 1.60$^{a}$ ± 0.01 | 0.15$^{b}$0.01 | 0.16$^{bc}$ ± 0.01 | 2.71$^{h}$ ± 0.01 | 27.02$^{g}$ |

**Table 2:** Chemical Composition of Almond Milk

Values are mean of three determinations ± standard deviation (n = 3). Values with different subscript within the same row are significantly different from each other.

increase value of 2.05 %. Similarly, hot water blanching of the almond kernels for 30 minutes to produce almond milk increased the moisture content by about 1.55% in comparison with the control. These values are comparable to a range of 90.36 to 93.45% for soymilk cooked for 15 to 45 minutes as reported by Orhevba [18]. However, the high moisture content noted with almond samples could affect the stability and safety of the with respect to microbial growth and proliferation, hence the products require cold storage.

The protein content was found to be in the range of 0.69% to 1.62%. Almond proteins play a major role in imparting its processing functionality. However, pre-treatment of almond nut by steam blanching and hot water blanching over time prior to milk extraction as well as pasteurization of almond milk resulted in a significant decrease in the protein levels of the milk. The nutrient loss is a general aftermath of various processing treatments. For example, the protein value for sample C (1.12%) and sample F (0.78 %) were lower compared to the control (1.62%). The pasteurization of almond milk produced 57.41% decrease in protein content compared to control sample. Heat treatment, depending on the processing conditions, can result in irreversible changes in milk protein structure. When milk is heated at temperatures above 65oC, proteins unfold and expose previously hidden hydrophobic groups. Following unfolding, proteins are capable to interact with themselves to form heat-induced protein aggregates of large molecular weights [19]. It is imperative to note that these changes at molecular level in the proteins may have impact solely on functional properties, such as solubility and emulsifying, but has no significant effect on their digestibility and nutritional properties as reported by Claeys., *et al*. [20]. The protein values reported were however lower than in tigernut milk [21], soy milk [22] and dairy milk [23].

The fat content was found to be in the range of 1.60% to 2.32%. There was significant fat content increase in hot water blanched and steam blanched samples respectively over time (5 - 30 minutes), with pasteurized sample showing the least increase compared to the control sample. The observed increase in fat content is due to the fact that heat aids extraction of oil which plays an important role in the texture and sensory quality of almond milk. Most importantly, *in vitro* [24] and *in vivo* [25] studies have revealed marked variations in lipolysis rates and postprandial blood triacylglycerol (TAG) concentrations between meals containing different forms of almond, which are mainly attributed to differences in lipid release (bioaccessibility). In the oil form, lipids were highly available and therefore fully digested (leading to a high concentration of TAG in the blood), whereas encapsulated nutrients (whole almonds) did not lead to a postprandial response as rapid and strong as the almond oil [26]. This behaviour is strongly linked to the resistance of almond tissue/cell walls to chemical and physical breakdown in the mouth, stomach and small intestine. When the oil bodies are released from the almond tissue, as this is the case in almond milk, they are highly digestible, and the rate and extent of lipolysis is similar to emulsified almond oil [26]. The enhanced fat content as a result of various heat treatments may however be accompanied by degradation of the protective components in the milk that have an antioxidant activity such as carotenoids. More so, heating causes decomposition of fat globule membrane that releases copper ions, which are known as active prooxidant. Consequently, the liberated oil will be more susceptible to oxidation than that protected by globule membranes in control sample.

The results obtained for ash value showed that mineral concentration was significantly ($p \le 0.05$) enhanced by milk pasteurization (sample F) compared with the value of control sample. Similarly, steaming and water blanching of almond kernels over time prior to milk extraction caused significant changes in the ash value respectively. However, the low level of ash noted in the milk samples indicates that almond milk is a poor source of mineral nutrition to the consumer. More so, the total ash in the various samples was lower than values reported for tiger nut milk [21]. The results reveal that heat treatment had slight though significant effect on fiber content of almond milk as indicated by a range of 0.11 to 0.28% when compared to untreated milk (0.16%). The preparation of almond milk is essentially accompanied with removal of insoluble fiber which explains the reported low values.

The carbohydrate content of almond milk produced from steamed and hot water blanched almond nuts for 30 minutes was 0.33 and 1.48% respectively, whereas, the carbohydrate content of the pasteurized milk was 1.17% against 2.71% in control sample. The carbohydrate content of almond milk samples was lower than the value reported for dairy milk [23]. It is also interesting to note that processing treatments had significant effect ($p \le 0.05$) on the energy value of the milk samples. The energy value ranged from 20.59 to 27.03 Kcal/g. Earlier study showed that the daily substitution of dairy product with almond milk caused statistically significant decreases in weight, body mass index and waist and hip circumferences over the study period. This may be attributed to the low-calorie content of almond milk compared with that of cow milk [27].

Results of the effect of processing treatments on mineral composition of almond milk are shown in tables 3. The concentration of calcium, magnesium, potassium and phosphorus was in the range of 8.62 - 20.00 mg/100 ml, 104.07 - 165.85 mg/100 ml, 220.71 - 303.89 mg/100 ml and 279.73 to 408.82 mg/100 ml. The application of heat in the milk preparation caused appreciable changes in values of the mineral content compared to the value obtained from the control. The values for calcium content were high when compared to 3.90 mg/100ml for of soymilk as reported by Alozie and Udofia [28]. However, the range reported for magnesium, potassium and phosphorus were higher than 30.00 mg/100 ml, 50.00 mg/100 ml and 49.00 mg/ml respectively reported for soymilk [28]. 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 [22]. The average calcium to phosphorus ratio obtained in the almond milk preparations was in the range of 0.03 to 0.05. Calcium to phosphorus ratio status is important in evaluating the nutritional value of foods as both elements are bone forming materials. The value is low compared to a value of 0.89 and 0.83 reported for cow milk and soymilk respectively [29]. More so, the range reported for almond milk in this study is far from the dietary reference intake (DRI) for health safety permissible within 1 - 1.3 [30]. In essence, there is need for fortification of almond milk with calcium to meet the required intake values recommended for the body. Similarly, the Ca/Mg ratios are low compared with the recommended value of 2.2 for maximum nutritional benefits [31].

| Sample | Calcium | Magnesium | Potassium | Phosphorus | Ca/P | Ca/Mg |
|---|---|---|---|---|---|---|
| A | $9.92^b \pm 0.03$ | $124.13^e \pm 0.12$ | $263.38^c \pm 0.03$ | $328.67^d \pm 0.35$ | 0.03 | 0.08 |
| B | $11.38^d \pm 0.02$ | $134.42^f \pm 0.04$ | $271.40^d \pm 0.02$ | $330.80^e \pm 0.06$ | 0.03 | 0.09 |
| C | $13.30^f \pm 0.03$ | $165.85^h \pm 0.05$ | $293.85^g \pm 0.02$ | $347.35^g \pm 0.09$ | 0.04 | 0.08 |
| D | $10.78^c \pm 0.02$ | $104.07^a \pm 0.03$ | $252.25^b \pm 0.05$ | $319.86^b \pm 0.13$ | 0.03 | 0.10 |
| E | $12.60^e \pm 0.15$ | $119.80^b \pm 0.02$ | $275.43^e \pm 0.03$ | $323.74^c \pm 0.23$ | 0.04 | 0.11 |
| F | $16.19^g \pm 0.03$ | $123.39^d \pm 0.02$ | $284.70^f \pm 0.20$ | $340.17^f \pm 0.04$ | 0.05 | 0.13 |
| G | $20.00^h \pm 0.10$ | $150.11^g \pm 0.03$ | $303.89^h \pm 0.10$ | $408.82^h \pm 0.20$ | 0.05 | 0.13 |
| H | $8.62^a \pm 0.02$ | $121.29^c \pm 0.02$ | $220.71^a \pm 0.54$ | $279.73^a \pm 0.25$ | 0.03 | 0.07 |

**Table 3:** Mineral Composition of Almond Milk (mg/100ml)

Values are mean of three determinations ± standard deviation (n = 3). Values with different subscript within the same row are significantly different from each other

### Effect of pre-treatment of almond kernels and heat treatment of almond milk on the microbial count of the produced milk

Table 4 shows the microbiological counts from almond milk after applying different treatments. Total viable counts decreased significantly ($p \le 0.05$) from 6.0 × 103 CFU/mL in sample H to no growth in sample G. Heat treatment of almond nuts prior to milk extraction as well as pasteurization of almond milk exerts bactericidal effect in the vegetable products. Application of pasteurization, however, showed a microbial reducing capacity better than steam and water blanching of the nuts prior to milk extraction. The absence of microorganisms in pasteurized sample showed that the pasteurization temperature at 72°C for 15 minutes was adequate. The better impact of pasteurization on the microorganisms in almond milk compared with other treatments can be a good argument for adoption of pasteurized almond milk in the market. Yuan., *et al.* [32] also reported reduction in microbial load in soy milk produced by consecutive blanching and ultra-high temperature processing of soybeans. Yeast and mould counts decreased from $2.4 \times 10^2$ CFU/mL in control sample to $1.0 \times 10^2$ CFU/mL in sample F. However, the yeast and mold counts were below the detection level in pasteurized product (sample G). It is imperative to note that characteristics of raw material (almond nuts) from its origin and subsequent handling determine the microbiota and spoiling micro-organism during the storage life of its derived products. Obviously, cold temperature storage under 4°C could be effectively extended the shelf-life of almond milk samples.

| Sample | Colour | Flavor | Taste | Mouth feel | Overall acceptance |
|---|---|---|---|---|---|
| A | $3.56^e$ | $2.50^{ab}$ | $2.69^a$ | $3.06^{ef}$ | $2.94^d$ |
| B | $3.44^c$ | $3.30^f$ | $2.94^c$ | $2.94^d$ | $3.38^f$ |
| C | $3.69^f$ | $3.06^e$ | $3.25^a$ | $3.31^g$ | $3.44^g$ |
| D | $3.63^d$ | $3.25^f$ | $3.06^d$ | $3.00^e$ | $3.19^e$ |
| E | $4.44^g$ | $3.31^g$ | $3.18^e$ | $3.38^h$ | $3.63^h$ |
| F | $3.13^b$ | $2.56^c$ | $2.75^b$ | $2.44^b$ | $2.63^b$ |
| G | $3.56^e$ | $2.88^d$ | $3.19^e$ | $2.88^c$ | $2.88^c$ |
| H | $2.69^a$ | $2.44^a$ | $2.69^a$ | $2.25^a$ | $2.50^a$ |

**Table 4:** Sensory Evaluation of Almond Milk

Values are mean of three determinations ± standard deviation (n = 3). Values with different subscript within the same row are significantly different from each other

### Effect of pre-treatment of almond kernels and heat treatment of almond milk on sensorial quality of the produced milk

The effects of hot water blanching and steam blanching at varying times on the sensorial quality of resultant almond milks are as presented in table 5. Other processing methods included; pasteurized almond milk and untreated almond milk (control). In terms of flavour, there were significant differences ($p \leq 0.05$) among the samples, mean scores ranged from 2.44 to 3.31. Preparation of almond milk from almond nuts without any treatment (control) resulted in milk with inferior flavour. The flavour score of almond milk from hot water blanched nuts (15 minutes) was higher than those of the other treatments. Unlike other vegetable milks, almond milk has no beany flavour and throat catching sensations. In case of taste, there were significant differences ($p \leq 0.05$) among samples, mean scores ranged from 2.69 to 3.25. Almond milk from steam blanched nuts (30 minutes) was most preferred while milks from steam blanched nuts (5 minutes) and untreated almond nuts were least preferred.

| Sample | Total Plate Count CFU/mL | Yeast and mold CFU/mL |
|---|---|---|
| A | $3.3 \times 10^3$ | $1.8 \times 10^2$ |
| B | $3.1 \times 10^3$ | $1.7 \times 10^2$ |
| C | $2.4 \times 10^3$ | $1.4 \times 10^2$ |
| D | $3.2 \times 10^3$ | $1.5 \times 10^2$ |
| E | $2.9 \times 10^3$ | $1.2 \times 10^2$ |
| F | $2.6 \times 10^3$ | $1.0 \times 10^2$ |
| G | ND | ND |
| H | $6.0 \times 10^3$ | $2.4 \times 10^2$ |

**Table 5:** Microbial counts (CFU/mL) of almond milk

* ND indicates that colonies could not be detected

In terms of colour, there were significant differences ($p \leq 0.05$) among the samples, mean scores ranged from 2.69 to 4.44. Almond milk from hot water blanched nuts (15 minutes) was most preferred while milk from untreated almond nuts was least preferred. Colour of almond milk is affected significantly by increasing the blanching time and pasteurization process. The preference of heat processed samples over the control is attributable to the temperature applied. The higher mean score of almond milk from hot water blanched nuts (15 minutes) for mouth feel compared to other samples was attributed to its lower fiber content. It is important to note that insoluble fibers should be eliminated to obtain milk with desired mouth feel properties and to avoid the perception of chalkiness [33]. Results obtained from the sensory evaluation indicated that almond milk prepared from hot water blanched nuts (15 minutes) had a significantly higher overall acceptability score (3.63) than other milk samples.

In general, vegetable milks face several quality aspects to be solved. Vegetable milks are colloidal systems formed by dispersed particles such as oil droplets, solid particles from raw materials, proteins and starch granules in some extent [34]. This complexity make difficult to obtain a stable product to be stored, even for a not very long time. Commonly in heat treated vegetable milks, as almond milk, sedimentable particles separate from the continuous phase causing lost of quality. The obvious rejection of some samples (below score of 3.00) could be as a result of unfamiliarity of the almond milk to panellists. Similar processing treatment carried out on tigernut milk, soymilk, almond milk and other similar Phyto milk recorded high acceptability which led to the commercialization of profile vegetable milk products in United States and European countries.

## Conclusions

The production of milk from almond kernels without any pre-treatment resulted in milk with inferior flavour. However, a relatively good yield and total solids were obtained when compared to other almond milk samples. It can be concluded that heat treatment of almond nut and heat treatment of the milk both affect the physical and nutritional quality of the produced milk in a complementary manner. Safety of almond milk, however, requires at least the application of pasteurization to inactivate microorganism totally.

## Conflict of Interest

The authors declare that there is no conflict of interest.

## Bibliography

1. Balogun AM and Fetuga BL. "Fatty Acid Composition of Seed Oils of Some Members of the Meliaceae and Combretaceae Families". *Journal of the American Oil Chemists Society* 62.3 (1985): 529-531.

2. Bolaji OS., *et al*. "Chemical Profile of the Mesocarp of three Varieties of Terminalia catappa L (Almond Tree)". *Journal of Applied Chemistry* 4.4 (2013): 10-12.

3. Annogu AA., *et al*. "Changes in Chemical Composition and Bioassay Assessment of Nutritional Potentials of Almond Fruit Waste As an Alternative Feedstuff for Lifestocks". *Biokemistri* 18.1 (2006): 25-30.

4. Lee J., *et al*. "Quantification of Amygdalin in Nonbitter, Semi-bitter, and Bitter Almonds (Prunus dulcis) by UHPLC-(ESI) QqQ MS/MS". *Journal of Agricultural and Food Chemistry* 61.32 (2013): 7754-7759.

5. Oduro I., *et al*. "Proximate Composition and Basic Phytochemical Assessment of Two Common Varieties of Terminalia catappa". *Journal of Science and Technology* 29.2 (2009): 1-7.

6. Yang J., *et al*. "Antioxidant and Antiproliferative Activities of Common Edible Nut Seeds". *LTW-Food Science and Technology* 42.1 (2009): 1-8.

7. AOAC. Association of Official Analytical Chemist. Official Methods of Analysis. 18th Edition. AOAC Press, Arlington, Virginia, USA (2000).

8. Ekanayake S., *et al*. "Proximate Composition, Mineral and Amino Acid Content of Mature Canavalia gladiata Seeds". *Food Chemistry* 66.1 (1999): 115-119.

9. Frazier WC and Westhoff DC. "Food Microbiology". 4th edition, McGraw Hill, New Delhi and New York (2010): 196-218.

10. Gaspar PM., *et al*. "Product Which Is Fermented Without Lactose from a Shake Comprising Vegetable Dried Fruits and/or Orgeat". European Patent Application (EPC) Art 158.3 (2007): 1-31.

11. Johnson WK and Snyder HE. "Soymilk, Comparison of Processing Method, Yield and Composition". *Journal of Food Science* 43.2 (1978): 349-353.

12. Parul J., *et al*. "Effect of Pressure Blanching on Sensory and Proximate Composition of Peanut Milk". *Journal of Food Science and Technology* 50.3 (2013): 605-608.

13. Akubor PI. "Physico-Chemical and Sensory Characteristics of Melon Seed Milk". *Journal Food Science and Technology* 35.1 (1998): 93-95.

14. Nnam NM. "Nutrient Composition and Acceptability of Vegetable Milk Made from Oil Seeds". *Journal of Home Economics Research* 5 (2003): 57-61.

15. Belewu MA and Abodunrin OA. "Preparation of Kunun From Unexploited Rich Food Source: Tiger Nut (*Cyperus esculentus*)". *Pakistan Journal of Nutrition* 7.1(2008): 109-111.

16. Ade-Omowaye BIO., *et al*. "Quality Evaluation of Beverage Produced from Pre-Treated Tiger Nut (*Cyperus esculentus*)". *Nigerian Food Journal* 27.1 (2009): 93-101.

17. Lewis MJ and Deeth HC. "Heat Treatment of Milk in Milk Processing and Quality Management". Wiley-Blackwell, Oxford 7 (2008): 1-37.

18. Orhevba BA. "The Effects of Cooking Time on the Nutritional Parameters of Soya Milk". *American Journal of Food Technology* 6.4 (2010): 298-305.

19. Donato L., *et al*. "Formation of Whey Protein/K-Casein Complexes in Heated Milk: Preferential Reaction of Whey Protein with K-Casein in the Casein Micelles". *International Dairy Journal* 17.10 (2007): 1161-1167.

20. Claeys WL., *et al*. "Raw or Heated Cow Milk Consumption: Review of Risks and Benefits". *Food Control* 31.1 (2012): 251-262.

21. Belewu MA and Belewu KY. "Comparative Physico-Chemical Evaluation of Tigernut, Soybean and Coconut Milk Sources". *International Journal of Agriculture and Biology* 9.5 (2007): 785- 787.

22. Onweluzo JC and Nwakalor C. "Development and Evaluation of Vegetable Milk from Treculia Africana (Decne) Seed". *Pakistan Journal of Nutrition* 8.3 (2009): 233-238.

23. Passmore R and Eastwood WA. "Human Nutrition and Dietetics". 8th edition. Churchill Living Stone (1986): 235-240.

24. Mandalari GC., *et al*. "Release of Protein, Lipid, and Vitamin E from Almond Seeds during Digestion". *Journal of Agricultural and Food Chemistry* 56.9 (2008): 3409-3416.

25. Berry SE., *et al*. "Manipulation of Lipid Bioaccessibility of Almond Seeds Influences Postprandial Lipemia In Healthy Human Subjects". *American Journal of Clinical Nutrition* 88.4 (2008): 922-929.

26. Grundy MML., *et al*. "The Role of Plant Cell Wall Encapsulation and Porosity in Regulating Lipolysis during the Digestion of Almond Seeds". *Food and Function* 7.1 (2016): 69-78.

27. USDA. United States Department of Agriculture. Nutrient Database for Standard Reference Release (2016).

28. Alozie YE and Udofia US. "Nutritional and Sensory Properties of Almond (Prunus amygdalu Var. Dulcis) Seed Milk". *World Journal of Dairy and Food Sciences* 10.2 (2015): 117-121.

29. Salau RB. "Nutritional Comparisons of milk from two Cow Specie and Local Preparations of Soya milk Drinks". *Journal of Applied Chemistry* 2.6 (2012): 41-44.

30. Virpi E., *et al*. "Low Calcium: Phosphorus Ratio in Habitual Diets Affects Serum Parathyroid Hormone Concentration and Calcium Metabolism in Healthy Women with Adequate Calcium Intake". *British Journal of Nutrition* 103.4 (2010): 561-568.

31. RDA. Recommended Dietary Allowances. National Research Council. National Academic Press Washington DC (1989).

32. Yuan S., *et al*. "Elimination of Trypsin Inhibitor Activity and Beany Flavor in Soy Milk by Consecutive Blanching and Ultra-High Temperature (UHT) Processing". *Journal of Agricultural and Food Chemistry* 56.17 (2008): 7957-7963.

33. Jihad M., *et al*. "Development of Vegetable Based Milk from Decorticated Sesame (Sesamum indicum)". *American Journal of Applied Sciences* 6.5 (2009): 888-896.

34. Ferragut V., *et al*. "Ultra High Pressure Homogenization (UHPH) treatment of vegetable milks. 11th International Congress on Engineering of Food. Athens, Greece (2011).


**Volume 2 Issue 6 June 2018**