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RESEARCH ARTICLE

Effect of cooking temperature on some quality characteristic of Almond milk

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ABSTRACT: Processing of almond was done at different temperatures (80, 90, 100 and 110°C), to produce almond milk samples (A, B, C and D). The almond milk sample (C) processed at normal boiling temperature (100°C) kept as reference standard. Using different standard analytical methods, almond milk were analyzed for physiochemical, microbiological, and sensory attributes. Due to increase in temperature the crude fat and moisture content decreased significantly ($p<0.05$) from 3.40 to 3.14% and 86.05 to 83.78%, respectively; while significant increase ($p<0.05$) were observed in protein, ash, crude fiber and carbohydrate contents. The pH and Total solids of almond milk significantly increased from 6.75 to 6.84 and 13.89 to 15.11% respectively. Total viable count significantly decrease ($p<0.05$) from 2.24-1.33×103 CFU/ml for sample A to D processed at 80-110°C, while yeast and mold from 1.22-0.35×102 CFU/ml. The mean value score awarded to all sensory attributes increase from A to C but decrease in D. Almond milk products were acceptable, highest acceptability score (8.33) awarded to milk sample C processed at 100°C followed by samples B, A and D. Processing of almond milk at 100°C provide the better milk product with all measured characteristics suggested for almond milk processing.
Keywords: Almond, Milk, Different temperature, Physicochemical, Total viable count, Sensory properties

INTRODUCTION

Almond *(Terminalia catappa Linn)* belongs to a group of nuts in which a single edible kernel enclosed in a hard shell and almond is an underutilized crop (Othmer, 1976). Almond tree belongs to the combretaceae family and also called tropical almond (Mbah *et al.,* 2013). On a worldwide basis in 2010, in tree nut production after the cashew nuts, almond rank is second with 2,560,000-2,565,000 metric tons (Ahmad *et al.,* 2013).

Almond milk consist as much as ash 3.04%, fat 3.40%, protein 1.70%, and carbohydrate 4.50%. This dairy free liquid is better substitute of animal milk and less expensive milk option chiefly where the animal milk is expensive and difficult. The world population continuously grows and protein supply is insufficient causes the rapid increase in malnutrition occurrence, mostly in developing countries worldwide (Siddhuraju et al, 1996). Therefore, in order to fulfil the requirements of protein in developing countries where protein from an animal source is insufficient and costly, research find the substitute sources of protein from plant origin (Nsofor and Maduko, 1992).

For body metabolism and building protein acceptability in the human diet is very effective because will consider as nutritionally important for man and animals. Recommended daily intake of protein is 68g for average Pakistanis of which 56-58% must be coming from the animal's origin (Milk and milk products) (FAO, 1991). For growing children and expectant mother's milk is considered as a compulsory part of the daily diet because it is a balance of lactose, protein, non-protein nitrogen, ash and fat (Sisay *et al.,* 2015).

Plant seeds play a significant role in human diets and their importance is increasing in developing countries because the increase in population (Brain and Alan, 1992; Christian, 2007). Plant seeds play an important role in our diet as well as potential raw material for industries because they contain a better amount of proteins, fats and edible oil (Enwere, 1998). Almond kernels consist of carbohydrates 23-25% protein 19-21% and fat 44-46% reasonable load of minerals (Nandi, 1998). For heart health improvement, almond kernels consist of a good amount of Phytochemicals, monounsaturated and polyunsaturated fatty acids. Almond kernel (raw) consists of natural nutrients, with some drawbacks such as the presence of anti-nutritional factors (secondary plant metabolites) (Yang *et al.,* 2001).

Plant milk commonly obtained from plants sources (seed) that look like milk fat and other components are absent. Due to the resemblance in nutritive, functional and sensory attributes these milks used as animal milk substitute (Enwere, 1998). Alternative of animal milk obtained from seeds, nuts and grains. These substitute sources have been identified due beneficial carbohydrates (low glycemic index), fatty acids, vitamins B and E, dietary fiber and antioxidants. Plant seeds are also a better source of low sodium and potassium, thus promote healthy calcium/phosphorus ratio. Substitute of milk obtained from plant sources and used as substitute to produce nutritious drinks. Among all of the plant milk sources, soybean has achieved better research attention, but peanut (Odo, 2001),

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groundnut (Obizoba and Egbunna, 1992), melon seed (Akubor, 1998), and tiger-nut (Ukwuru *et al.,* 2008) gain less attention while underutilized almond seeds acquire no attention.
Several investigators reported that different processing techniques such as boiling, sprouting, blanching, roasting, autoclaving and microwave treatment to enhance the nutritional quality of food products and reduce the anti-nutrient (Esenwah and Ikenebomeh, 2008; Słupski, 2008). With this viewpoint increased utilization of almond milk in the human diet, the current research was to establish the effect of different cooking temperatures on the quality characteristics of almond milk.

MATERIAL AND METHODS

2.1. Raw material

For almond milk production almond was purchased from Local market, Faisalabad, Punjab. Laboratory apparatus and chemical reagents were used in the Institute of Home and Food Sciences, Faculty of Science and Technology, Government College University Faisalabad, Pakistan.

2.2. Almond milk preparation

After separation of infested kernels, washing was done and kernels were sun dried for four days and cracked along the ventral sutures to obtain the nuts. For dehulling almond nuts were soaked in hot water and then remove skin by rubbing. Then dehulled nuts are soaked in de-ionized water at 4°C for 5-6 hours after that drained, rinsed and kitchen blender at maximum speed with 1:3 (w/v) ratio for 5 mints used for wet milling (Kenwood, England). Double layered cheese cloth was used to filter the resultant slurry. Infiltrate, 200ml sugar syrup (200g sugar in 50ml water was made by boiling) was added then homogenization and pasteurization was done at 120-122^{0}C for 15min. After that, 15ml vanilla flavor was added in sterilized screw tight plastic bottles and stored (4°C).

2.3. Almond milk analysis

2.3.1. Proximate composition

Crude fiber, crude protein, crude fat, moisture and ash were evaluated according to the method of (AOAC, 2005). The pH was calculated by using digital pH meter (WPACD 60) by using the method narrated by Mweta (2009), while Carbohydrate was estimated by difference (Ihekoronye and Ngoddy, 1985). Total solids of almond milk were measured gravimetrically according to the method narrated by Bradley (2003). All the analysis were done in triplicates.

2.3.2. Microbiological analysis

Frazier and Westhoff (2010) described pour plate method was used for the estimation of Total Viable count, mold and yeast count. For total viable count serial dilutions of samples were pour into plate count ager and after that incubation was done at 36±19°C for 48 h. Malt extract agar was used for yeast and mold and incubation of plates were done at 26±36°C for 4-5 days.

2.4. Sensory evaluation

A 10 member panelist judges of the Institute of Home and Food Sciences, Faculty of Science and Technology, Government College University Faisalabad, Pakistan. For sensory attributes 9 point hedonic scale was used for mouth feel, color, flavor and general acceptability (Iwe, 2002).

2.5. Statistical analysis

All research findings were done in triplicates. Obtained values were undergo Analysis of Variance (ANOVA) using MINITAB 17 edition. Tukey's test was used to evaluate the least significant difference between all the mean values.

RESULTS AND DISCUSSION

3.1. Physicochemical properties

Table 1 shows that the mean values of different samples for physicochemical characteristics. Fat and moisture contents reduce significantly ($p<0.05$) due to increase in cooking temperature form 3.40-3.14% and 86.05-83.78% respectively from samples A to D. Decrease in fat and moisture content could be happening due to water evaporation and fat volatilization occur by heating at different temperature during cooking of slurry . On the other hand, significant ($p<0.05$) increased was measured in crude fiber, ash, crude protein, total solid and carbohydrate due to the increase of cooking temperature. Above mention physiochemical parameters were increased due to the concentration effect because cooking temperature increase fat and water content from almond milk reduce, other milk constituent improved, thus the nutritional quality of almond milk increase.

Obvious increase in nutritional constituent with increase in processing temperature, due diligence must be exercised in almond milk production due to the use of heat. During heating it was observed that excessive cooking or heating treatment can decrease the

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availability and digestibility of growth essential amino acids lysine, cysteine and many more amino acids in which serine, histidine, arginine and tryptophan present in almond kernel (Ezeokonkwo, 2005). Cysteine and lysine are heat sensitive, destruction of lysine occurs due increase in processing temperature and become unavailable because lysine amino group so modified is physiologically unavailable (Yuan *et al.,* 2008). For tryptic cleavage the peptide bond consists of modified lysine not susceptible. Almond protein digestibility due to proteolytic enzymes, therefore digestibility considerably decrease when protein undergoes excessive heat during processing. Mbah *et al.,* (2013) suggested that the maximum nutritional value of almond proteins is obtained by processing treatment with live steam for about 5mint and by autoclaving at 15lb/in pressure for 5mint. Its mean that processing of almond milk at 110°C or above for 25-30min cause destruction of almond protein.

Effect of different cooking temperature on crude fiber of almond milk has a significant effect ($p<0.05$) on nutritional development and increase in crude fiber is occur due to the formation of protein-fiber complex after some chemical changes at heating. Crude fiber does not take part as nutrients pint of view in the human body and adds as a bulky in food. Crude fiber preventing from many gastrointestinal diseases and make easier peristalsis (Bowel movement) (Gordon, 1999).

Carbohydrate among all the treatments was significantly increased ($p<0.05$). The amount of carbohydrate increase mean calories increase in food product. Yau-Chun *et al.,* (2008) postulate that carbohydrate content in almond kernel was increased during blanching and autoclaving. Carbohydrate is good source of energy for all body functions and their deficiency in human body lead toward depletion of body tissues (when body change protein and fat into energy) (Gordon, 1999) [27].

pH of different almond milk samples was slightly increased and significantly effected ($p<0.05$) with increase in cooking temperature. pH values varies from 6.74 to 6.88 for A to Sample D, pH values below 7 (neutral) is an indication almond milk samples will safe from microbial attack or growth.

3.2. Microbiological analysis

Microbiological properties of the almond milk samples are given in Table 2. Total viable count among all the milk samples significantly decrease ($p<0.05$) due to increase in cooking temperature. Reduction in total viable count was recorded from 2.24×10^3 CFU/mL to 1.33×10^3 CFU/mL for sample A to D respectively. Yeast and mold count among all the samples at different temperature also significantly decrease ($p<0.05$) from 1.22×10^2 CFU/mL to 0.35×10^2 CFU/mL for sample A to D respectively. Reduction in the total viable count and yeast and mold count effected by processing temperature. Yuan *et al.,* (2008) describe that microbial count in soy milk was reduce by ultra-high temperature processing during milk production. That's why, the acceptable limits of total viable count for non-dairy milk products were10^7 CFU/mL suggested by ICMCF (1974).

3.3. Sensory properties

The mean score for sensory attributes of almond milk at different temperature are present in Table 3. Sensory attributes (color, mouth feel, flavor and general acceptability) among different samples of almond milk significantly increased ($p<0.05$). In case of color, it was observed that the mean score increase from 5.92, 6.52 and 7.45 respectively in sample A to C but decrease in sample D (7.00) and the pattern observed in flavor and mouth feel. Mean score for general acceptability also increase from 5.90, 6.62 and 8.35 in sample A to C respectively but decrease in Sample D (5.85). Color intensity significantly ($p<0.05$) increased due the Millard reactions, usually occur between the amino groups (Protein and amino acid) and reducing sugars. These type of reactions are promoted by increase in pH, temperature and reactant concentrations along with some essential amino acid destruction (Alais and Linden, 1991).

Torres-Peneranda (1998) was also reported that the milk made from soybean (lipoxigenase-free) and normal soybean during processing in which these sensory attributes was increased. In sample D flavor score decrease as a result to attain off flavor due to the cooking or processing of almond milk at higher temperature. Almond milk at this concentration, become heavier, thus mouth feel has also increase and unacceptable for judges.

At the end all the almond milk products were satisfactory, but the milk simple process at 100°C (sample C) awarded highest score of acceptability of 8.35, follow by samples B, A and D in that sequence.

CONCLUSIONS

This research has exhibited that the almond milk organoleptically acceptable and with high nutritional value could be formed without any apparent defects at cooking temperature varies between 80 -110°C. But, even though cooking of almond milk at 110°C gave nutritious and microbiologically more secure products, cooking at a 100°C gave almond milk that was most suitable to consumers.

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Table 1. Physicochemical attributes of almond milk samples

Parameters	A	B	C	D	LSD
Moisture (%)	86.05±0.02[a]	85.07±0.10[b]	84.20±0.07[c]	83.78±0.06[d]	0.23
Protein (%)	1.70±0.05[b]	1.73±0.02[b]	1.75 ±0.01[a]	1.80±0.02[a]	0.06
Fat (%)	3.40±0.03[a]	3.31±0.05[b]	3.23±0.03[c]	3.14±0.06[d]	0.05
Ash (%)	3.04 ± 0.05[b]	3.08±0.02[b]	3.11±0.02[a]	3.16±0.02[a]	0.04
Fiber (%)	1.25 ± 0.10[b]	1.32±0.01[b]	1.65±0.02[a]	1.70±0.04[a]	0.07
Carbohydrate (%)	4.50 ±0.20[c]	5.02±0.04[b]	5.11±0.04[b]	5.31±0.06[b]	0.18
Total solid (%)	13.89±0.06[d]	14.46±0.05[c]	14.85±0.02[b]	15.11±0.17[a]	0.16
pH	6.75±0.15[c]	6.79±0.02[b]	6.81±0.01[a]	6.84±0.01[a]	0.03

Mean values with standard deviation in a row are significantly different ($p \leq 0.05$); (Key= Sample A cooking at 80°C, B at 90°C, C at 100°C and D at 110°C)

Table 2: Microbiological properties of almond milk samples (CFU/ml)

Parameter	A	B	C	D
Total Viable count	2.24×10^3	2.04×10^3	1.76×10^3	1.33×10^3
Yeast and mold count	1.22×10^2	1.02×10^2	0.95×10^2	0.35×10^2

Significance level ($p \leq 0.05$); (Key= Sample A cooking at 80°C, B at 90°C, C at 100°C and D at 110°C)

Table 3. Mean value score for sensory attributes for almond milk samples

Parameter	A	B	C	D	LSD
Color	5.92[b]	6.52[a]	7.45[a]	7.00[a]	1.02
Mouth feel	5.67[b]	6.34[b]	7.66[a]	7.12[a]	0.88
Flavor	5.89[b]	6.69[b]	8.13[a]	7.15[a]	1.31
General acceptability	5.90[c]	6.62[b]	8.35[a]	5.85[c]	0.67

Significance level ($p \leq 0.05$); (Key= Sample A cooking at 80°C, B at 90°C, C at 100°C and D at 110°C)

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CONFLICTS OF INTEREST

"The authors declare no conflict of interest".