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Comparative Evaluation of Some Physicochemical Properties for Different Types of Vegan Milk with Cow Milk

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ABSTRACT

The possibility of making vegan milk from decorticated sesame seed, almond, and peanut and their utilization in the production of dairy imitations was investigated, compared with cow milk. Sesame seeds, almond and peanut were soaked separately in tap water containing 0.5g/ $NaHCO_3$/L water for 12h at room temperature, then drained and washed with fresh tap water, steamed for 15 min, followed by cooling directly in cold water, then draining from excess water and grinding in adequate quantity of distilled water for about 20 min, then filtering through cheese cloth. The obtained milk was pasteurized and stored at 4 ± 1 °C for 14 days. The chemical, physical analysis and sensory properties were done for different vegan milk and cow milk. Results showed that fat content in almond milk was 7.6%, protein content of peanut milk of 3.5%, and the highest potassium content of 1620 mg/l was detected in almond milk, followed by peanut milk of 1415 mg/l. The obtained results clarified that sesame milk contained more zinc and iron than the other vegan milk. Saturated fatty acid content of vegan milk was 8.12, 17.2, 20.2% of total fat for almond, peanut and sesame milk, respectively. In addition vegan milks were richer in unsaturated fatty acids of 91.66, 82.58 and 79.67% for almond, peanut and sesame milk, compared with cow milk (23.12%). All vegan milks were found to be richer in some essential amino acids (such as Threonine, Arginine, Valine, Isoleucine, Leucine and Lysine) than cow milk. Thus we recommend to use the studied vegan milk as dairy free product for the people who suffer allergies from cow milk.
Keywords: cow milk, almond milk, peanut milk, sesame milk

INTRODUCTION

Milk may be consumed in its natural form or used for making a wide range of food products, including cream, butter, yoghurt, cheese and ice-cream. Moreover, substantial continuous increase in population densities and inadequate of protein supply has advertently increased the occurrence of malnutrition in developing countries (Siddhuraju et al., 1996). However, in order to meet the requirement of protein demands in developing countries where animal protein is grossly inadequate and relatively expensive, research effort is geared towards finding an alternative sources of protein from vegetarian foods (Nsofor and Maduko 1992).

Vegan milk is a general term for a product that is derived from a plant source that resembles milk but contains neither milk fat nor other important dairy product 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 for people who suffer from cow milk allergies. Such alternatives have been characterized by a profile of healthy fatty acids and carbohydrates with low glycaemic index as well as constituents of vitamins B, E, antioxidants (Phytosterols and/or polyphenols) and dietary fiber(Potter and Hotchkiss 1995).. These are also rich sources of potassium and low sodium which considered as promoters of healthy balance of electrolytes as well as good calcium/phosphorus ratio. Development of milk substitutes extracted from plant sources serves as an alternative source of producing special acceptable nutritious drinks (Alozie and Udofia, 2015).

Milk extracts from plant base-foods can be used as supplements in the diets of pre-school and school children and can be used as substitute for ordinary milk (Onweluzo and Nwakalor, 2009; Asiamah, 2005).

Peanut (*Arachis hypogaea*L.) is highly nutritious and it has been found richer in calories, protein, minerals and vitamins than beef. It is also an excellent source of vitamins B- complex, vitamin E and essential amino acids (Sanni et al., 1999)..

Sesame (*Sesame indicume* L.) seed one of the most significant oil seed crops in the world. Sesame seed contains remarkable amounts of characteristic lignans such as sesamin, sesamoline, sesaminol and others. Sesame lignans have been noted as the most significant components of sesame seed on account of their various functional components. Some lignans are known to have antitumor, antimitotic, and antivirus activities (Namiki, 2007).

It has been shown that almond is a nutritious food which a 100 gram serving providing more than 20% of the daily value of riboflavin, niacin, vitamin E, calcium, iron, magnesium, manganese, phosphorus and zinc.. It is also rich in dietary fiber, monounsaturated fats and polyunsaturated fats, which may lower LDL cholesterol. Nuts and seeds of almonds contain phytosterols such as beta-sitosterol, stigmasterol, campesterol, sitostanol and campstool, which have been associated with cholesterol-lowering properties. So, almonds are considered of a great source of proteins, dietary fibre, health-promoting unsaturated fatty acids, vitamin E, other vitamins, minerals; they are also low in saturated fats, and contain no cholesterol (Miraliakbari & Shahidi 2008 and Berryman et al., 2011).).

Therefore, in this study was conducted to use sesame seeds, almond and peanut as a three alternative veg plant materials for preparing vegan milk products. The evaluation of physiochemical properties in addition to their sensory properties were conducted in comparison to cow milk as fresh and during storage at 4°C for 14 days.

MATERIALS AND METHODS

White dehulled sesame seeds, almond and peanuts were purchased from local market in Cairo, Egypt.(Table 1).

Table 1. Chemical composition for almond, peanut and sesame

Component (%)	Almond	Peanut	Sesame
Fat	55.8	44.9	51.8
Protein	17.6	26.4	19
Total Carbohydrate	19.3	21.7	20
Ash	2.7	2.4	4.6
Moisture	4.6	4.6	4.6

For the preparation of sesame milk, almond milk and peanut milk, Sesame, almond and peanut were soaked separately in tap water containing 0.5 g $NaHCO_3$/L water for overnight at room temperature (25°C). After draining each of the soaked seeds them were washed using fresh tap water, integrated with water: each of different seeds 2:1, followed by steamed for 15 min, (over steam bath) then cooled directly by immersing in cold water, followed by draining the excess water and grinding through in an adequate quantity of distilled water for 20 min, then t filtering through a double layered cheese cloth. The obtained milk was pasteurized at 85°C for 30 min and stored at 4 ± 1 °C before further analysis for a duration period of 14 days.

The pH values of the different milk samples were measured at 25°C by digital pH meter Type HANNA instrument (8417). Total solids, protein, ash, fatty acids, amino Acids peroxide value were analyzed and estimated according to the AOAC (2012). Fat content for the prepared vegan milk analyzed as AOCS method (AOCS, ANKOM Technology Method 2005) .Fat content of cow milk was determined using modified Gerber method as described by Ling (1963).

Sensory properties for different milk samples were evaluated as described by Land and Shepherd, (1988). Fifteen trained panelists' team from the research staff of the Department of Dairy science Sections, Animal Production, Research Institute, Agricultural Research Center were participated in the sensory evaluation of the prepared milk. Milk samples were evaluated of fresh and various storage periods and 14 days using score card for flavor.

RESULTS AND DISCUSSION

Results of the composition of vegan milk in Fig (1) showed that sesame milk was of the highest pH values (7.24). Total solids (T.S) in all samples were nearly similar to values reported in melon seed milk (12.0%) and cow milk (12.9%) (Omole and Ighodaro, 2012). The fat content in almond milk was of the highest (7.6%), followed by sesame milk (6.98%), peanut milk (6.02%), as compared with cow milk (3.7%). Protein content of peanut milk samples in this study was of the highest (3.5%). Moreover, peanut milk protein was higher than values of cow protein milk (3.30 %), followed by sesame milk (2.57%), almond milk (2.4). Generally, the composition and balance of amino acid of milk samples were of greater importance than quantity of protein. Whereas cow milk showed higher values of total carbohydrate and ash contents as compared with vegan milk samples. The results showed that total carbohydrate content of cow milk (5%) was higher than values reported for vegan milk samples

Fig 1. Composition of different vegan milks and cow milk

The mineral composition of vegan milk were shown in Table (2). Results show differences between milk types in all mineral assayed. Mineral composition of different types of vegan milk varied with the level of minerals in the seed of extraction, extraction method, seed/extractant ratio among others, which agrees with Onweluzo and Nwakalor, (2009).

Table 2. Minerals content of different types of vegan milk and cow milk

Component	Cow	--------------- Vegan milk--------		
		almond	peanut	sesame
Calcium	1230	28.05	750	945
Potassium	1380	1620	1415	850
Zinc	3.8	3.14	8.5	9.75
Iron	2.1	4.53	4.1	7.44

Vegan milk contained appreciable amounts of calcium, potassium, zinc and iron. Also, it could also be noticed that vegan milk have lessen resistance of veins and arteries resulting in better flow of blood, oxygen and nutrients due to the presence of these natural minerals. Ensminger and Ensminger, 1999). Kirbaslar, et al (2012) found that mineral composition and caloric values of some nuts and seeds from Turkey are rich of these compounds. It was also found that cow milk was richer in calcium content (1230mg/l) than sesame milk (945mg/l). The high potassium content was found in almond milk (1620 mg/l), followed by peanut milk (1415 mg/l).

Sesame milk contained more zinc and iron (9.75, 7.44 mg/l), compared with other tested cow, almond and peanut milk (3.8, 2.1; 3.14, 4.53; 8.5, 4.1 mg/L, respectively). Results in this study are in agreement with Isangaa and Zhanga (2009).

Data in Table (3) clarified that different types of vegan milk were richer in unsaturated fatty acids (mainly oleic acid and linoleic acid), almond milk contain (91.66%) followed by peanut milk (82.58%) then sesame milk (79.67%). In addition, sesame milk contained more poly unsaturated fatty acids (PUFA) (44.35%) followed by peanut milk (34.06%) then almond milk which contain 25.34% and cow milk which recorded 1.6% On the other hand cow milk was richer in saturated fatty acids content (75.6%) (Mainly Palmitic, Stearic and Myristic) as compared to various vegan milk (almond milk 8.12%, peanut milk 17.2% and sesame milk 20.02%). It has Yu-Poth, et al. (2000) reported that substitution of saturated fatty acids with monounsaturated fatty acids like oleic acid leads to increased high-density lipoprotein (HDL) cholesterol and decreased low density lipoprotein (LDL) cholesterol, triacylglycerol (TAG), lipid oxidation, and LDL susceptibility to oxidation. Thus, Vegan milk can be considered to be more health promoting source than cow milk in which the proportion of saturated fatty acids are higher than that of unsaturated fatty acids

Table 3. Fatty acids composition (%) of different types of vegan milk and cow milk

Fatty acids	**cow milk**	**Almond milk**	**Peanut milk**	**Sesame milk**
C4:0 Butyric	6.06	-	-	-
C6:0 Caproic	5.71	-	-	-
C8:0 Caprylic	2.29	-	-	-
C10:0 Capric	3.85	-	-	-
C11 :0:Undecanoic	0.42	-	-	-
C12 :0 :Lauric	3.59	-	-	-
C14:0 Myristic	11.41	0.11		0.84
C16:0 Palmitic	32.79	6.56	11.26	13.46
C16:1(Palmitoleic)	1.5	0.48	0.10	
C16:3		0.12		
C17:1Heptadecanoic			0.10	
C18:0 Stearic	9.52	1.45	2.71	5.72
C18:1n7t Vaccenic	1.8	1.54		1.43
C18:1n9c Oleic	16.0	64.0	47.46	31.73
C18:2n6c Linoleic	3.3	25.22	34.06	44.35
C20:0 Arachidic	0.2		1.16	
C20: Gadoleic	6.4	0.30	0.95	2.16
C22:0 Behenic)	0.03		1.98	
Nonidentified	0.33	0.22	.22	.31
SCFA (C4-C14)	34.4	-	-	-
MCFA (C15–C17)	35.0	7.16	11.46	13.46
LCFA (C18–C22)	30.7	92.51	88.32	85.39
*SFA	75.6	8.12	17.20	20.02
**MUFA	21.52	66.32	48.52	35.32
***PUFA	1.6	25.34	34.06	44.35

***Saturated fatty acid ** Mono unsaturated fatty acid *** Poly unsaturated fatty acid**

Different vegan milk were found to be richer in some essential amino acids (such as Threonine, Arginine, Valine, Isoleucine, Leucine and Lysine) than cow milk Table (4). However cow milk was richer in other essential amino acids (like Histidine and Phenylalanine) than vegan milk. The essential amino acids are arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, and valine. (Histidine is required by infants, but it has not been fully established if it is essential for adults.) They must be available simultaneously in the correct proportion for protein synthesis to take place efficiently, which agrees with Rodwell & Kennelly, (2003).

Table 4. Amino acids composition (mg/ml) of different types of vegan and cow milk

Amino acid	Cow milk	Almond milk	Peanut milk	Sesame milk
Aspartate (Asp)	3.6	5.0	6.6	5.0
Glutamate (Glu)	3.1	3.0	2.4	2.7
Serine (Ser)	2.2	1.94	2.0	1.98
Histidine (His)*	2.31	1.85	1.86	1.88
Glycine (Gly)	7.17	2.15	2.20	2.15
Threonine(Thr)*	1.13	6.9	7.1	7.5
Arginine(Arg)*	1.29	2.85	2.90	3.0
Alanine Ala)	2.19	7.8	0.76	8.1
Tyrosine(Tyr)	7.42	3.5	3.60	3.66
Cystein (Cys)	-	-	-	-
Valine (Val)*	1.13	3.03	2.99	3.05
Methionine (Met)*	-	-	-	-
Phenylalanine(Phe*	6.25	3.6	3.5	3.6
Isoleucine (iIe)*	0.8	2.77	2.75	2.80
Leucine (Leu)*	0.8	3.5	3.5	4.0
Lysine (Lys)*	1.85	3.1	3.4	3.2
Proline (Pro)	2.64	0.9	0.9	1.0

***Essential amino acid**

Results recorded in Table (5) showed higher peroxide content in cow milk of 0.38 meq /kg, compared with different vegan milk samples which ranged between 0.280 ,0.091, 0.056 in almond , peanut and sesame milk samples, respectively. Cow milk recorded higher peroxide value due to the notable increase in its saturated fatty acids (palmitic and Stearic), as compared with different vegan milk fatty acids samples. Almond milk recorded higher peroxide value for various types of vegan milk, this may be for its high content of fat content followed by sesame then peanut milk.

Table 5. Peroxide content (meq/kg) for different vegan milks and cow milk during refrigerated storage at(4±1°c)

		---------Vegan milk------		
Peroxide value	**Cow milk**	**almond**	**peanut**	**sesame**
fresh	0.38	o.280	0.091	0.056
14 day	0.324	0.272	0.037	0.075

It is well known from literature that greater the number of double bonds contained in fat, more it is prone to oxidation deterioration (Erickson and Frey, 1994; Sardesai, 2003; Fennema, 1985). It could also be noted that vegan milk samples did not show noticeable effect on their peroxide value during cold storage whether fresh or after 14 days.

Table (6) showed the results of the sensory evaluation of the different vegan milk types compared with cow milk during refrigerated storage. Almond milk was judged the best in color, flavor and taste, over all acceptability (9).These results are in agreement with Alozie and Udofia, (2015).

The overall acceptability values of different vegan milk samples and cow's milk ranked final acceptance between 7 and 9 as fresh. The obtained results clarified that the overall acceptability decreased between 7-6.5 after 14 days of cold storage for all milk types.

Table 6. Sensory properties of different types of vegan milk and cow milk during storage periods at (4±1°c).

			---------Vegan milk------		
storage period (days)	**properties**	**Cow**	**almond**	**peanut**	**sesame**
fresh	Color	9	10	8	10
	Flavor	8	9	7.5	8
	Taste	8.5	9	7.5	7.5
	overall accept	9	9	7	8
	Color	9	10	8	10
	Flavor	6.5	8	6.7	6.5
	Taste	7	8	6.5	6.5
	overall accept	7	7.7	6.5	7

CONCLUSION

Almond milk is nutrient dense if compared to other vegan milks such as sesame and peanut milk. Its high content of potassium is essential for gastrointestinal and cardiovascular health. Whereas, sesame and peanut milk contain high level of trace minerals especially iron and zinc which are 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. In addition different vegan milks in this study were rich in unsaturated fatty acids and less saturated fatty acids as compared with cow milk. Thus we recommend to use the studied vegan milk as dairy free product for the people who suffer allergies from cow milk and to fortify the dairy proudcts with high nutritionally other sources.

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مقارنه لبعض الخصائص الفيزيوكيميائية لأنواع مختلفة من الالبان النباتية مع اللبن البقرى

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في هذا البحث تم دراسة إمكانية إنتاج البان نباتية مختلفة من بذور السمسم المقشور، اللوز، والفول السوداني واستخدامها في إنتاج منتجات البان بديله، ومقارنتها مع اللبن البقرى. تم نقع بذور السمسم، اللوز والفول السوداني بشكل منفصل في المياه مع اضافة كربونات صوديوم بنسبة ٠.٥ جم / لترلمدة ١٢ ساعة في درجة حرارة الغرفة ثم يغسل بماء الصنبور، ويوضع على البخار لمدة ١٥ دقيقة، يليها التبريد مباشرة في الماء البارد، ثم يصفى من المياه الزائدة ويطحن في كمية كافية من الماء المقطر لمدة حوالي ٢٠ دقيقة ويصفى من خلال قطعة من الشاش. ثم يتم بسترة المستخلص الناتج (اللبن) الذي تم الحصول علية وتخزينة على ٤ ± ١ درجة مئوية لمدة ١٤ يوما، تم القيام بعمل التحاليل الكيميائية والفيزيائية والخواص الحسية للالبان النباتية المختلفة واللبن البقرى طازجا وبعد التخزين ، وأظهرت النتائج أن نسبة الدهون في لبن اللوز سجلت اعلى قيمة ٧.٦ ٪ ، محتوى البروتين من لبن الفول السوداني سجلت أعلى قيمة (٣.٥٪) واعلى محتوى للبوتاسيوم فى لبن اللوز (١٦٢٠ ملغم / لتر) تليها لبن الفول السوداني، أوضحت النتائج أن لبن السمسم يحتوي أعلى نسبة من الزنك والحديد (٩.٧٥ ، ٧.٤٤). اوضحت هذه دراسة ان اللبن البقرى غنيى في الأحماض الدهنية المشبعة (% ٧٥.٦) فى حين اللبن النباتي اقل منه (٨.١٢،١٧.٢،٢٠.٢) للوز والفول السوداني والسمسم على التوالي . بالإضافة إلى ان الالبان النباتية المختلفة كانت أكثر غنى بالأحماض الدهنية غير المشبعة اللوز والفول السوداني والسمسم(٩١.٦٦،٨٢.٥٨ و٧٩،٦٧٪) بالمقارنة مع اللبن البقرى (٢٣.١٢٪). وقد لوحظ ان أنواع الالبان النباتية المختلفة أكثر ثراء في بعض الأحماض الأمينية الأساسية (مثل ثريونين، أرجينين، فالين، الايزوليوسين، لوسين وليسين) من اللبن البقرى. سجل لبن اللوز أعلى محتوى من البيروكسيد خلال فترات التخزين.
لذلك توصى هذه الدراسة بإمكانية استخدام هذه الألبان فى تدعيم بعض المنتجات اللبنية لإرتفاع محتواها من بعض العناصر الغذائية ، كما يمكن استخدامها فى تغذية الأشخاص الذين يعانون من حساسية لمنتجات الالبان.