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Making some alternative milks and using them in preparing food products suitable for lactose intolerance Patients

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Abstract

Lactose sensitivity is the reaction of the digestive system to not accepting the lactose present in milk, which causes painful symptoms after eating dairy products. Therefore, the current study aimed to manufacture and use some alternative milk in the preparation of food products suitable for patients with lactose intolerance. For this purpose, four food products were prepared (cream caramel, Ice cream, rice pudding, and pudding) using three types of alternative milks (sesame milk, cashew milk, and coconut milk). A sensory evaluation of the products was done, in addition to studying the chemical and mineral composition and color measurements of alternative milks and comparing them with cow's milk. The results of the sensory evaluation showed that there was a high level of acceptance of the products in which the alternative milks used in the study were used. The products in which coconut milk was used for its preparation got the highest score after cow's milk. The study of the chemical composition showed that coconut milk contained the highest percentage of fat and ash compared to other types of milk, while sesame milk contained the highest Fiber percentage. As for cashew milk, it contained the highest percentage of carbohydrates. As for the results of colorimetric measurements, there were significant differences between the used alternative milk and cow's milk, at a significant level of less than 0.05. Therefore, the study recommends the use of sesame milk, cashew milk, and coconut milk in preparing meals for patients with lactose intolerance.

Key words: alternative milk, lactose sensitivity, chemical composition, color measurement, sensory properties.

Introduction:

In recent decades, the consumption of functional nutrients has increased due to the massive increase in the direction of healthy diets; Functional foods are those that promote health benefits beyond basic nutritional functions, when consumed in usual diet **(El-sayed *et al.*, 2014**). Milk is a complete food that provides a diet rich in nutrients (**Muthukrishnan et *al*., 2021**). In this regard, it is an essential component of the diet of about 7 billion individuals. Furthermore global milk production is 730 million tones' per year, In addition, lactose is the main sugar in milk and participates in calcium absorption, and magnesium, but some individuals have lactase deficiency, where lactose is not absorbed in the intestine so it is fermented by the colon micro biome, which leads to the production of fatty acids and gases such as methane, carbon dioxide, hydrogen (**Karunasiri *et al*., 2020).**

Milk is a bluish-white liquid secreted by the glands of female mammals. Whole milk contains 3.9 g of fat per 100 g of full-cream milk (**Milovanovic *et al*., 2023).** The main protein in milk consists of casein, which reaches 80% and is precipitated at PH = 4.5. Milk salts include organic salts and inorganic salts such as sodium, potassium, and calcium **(Facioni *et al*., 2020).**

Lactose is the primary carbohydrate in milk it is a disaccharide of galactose and glucose units linked by (B1-4 glycoside bond). Lactose is a reducing sugar and exists as a and Banomies in solution and forms vary in solubility, crystal shape, and size. Mutation of lactose depends on temperature and pH. Lactose crystallizes much faster than other sugars, like sucrose. The crystallization of lactose leads to the formation of large crystals, which are associated with sandy texture defects in sweetened condensed milk and ice cream **(Chandan, 2006).**

Lactose in milk has a comparatively lower glycemic index compared to glucose or sucrose, making it suitable for diabetic people. Lactose reduces sugar and reacts with amines (lysine and N-terminal amines) to form Schiff base adducts, which subsequently undergo a series of non-enzymatic reactions leading to browning and caramelization. Lactose prevents infection by stimulating the bifid bacterium in the colon. Improving colon health **(Adolfson, 2004)**

The lactose content of milk varies between 3.6 and 5.5%. Lactose is attacked by lactic acid bacteria, which contain an enzyme called lactase, which attacks lactose from the lactic acid bacteria, then attacks glucose and galactose, converting them into various acids, of which lactic acid is the most important thing is that this is what happens when milk goes sour **(Abdallwahab *et al*., 2017).**

Regarding lactose intolerance, some individuals have some health problems associated with milk, which has led them to seek alternatives to alternative milks, Where it is considered the best choice for them because they cannot absorb and digest cow's milk protein and are lactose intolerant (**Wolf *et al*., 2020)**. Lactose intolerance symptoms include abdominal pain, bloating, nausea, and diarrhea. Therefore, these symptoms are from inside the intestine (**Vesa *et al*., 2000**).

There are other symptoms that are outside the intestine, such as headaches, pain in the muscles and joints, mouth ulcers, heart palpitations, eczema, and increased urination **(Griffin *et al.*, 2017**).

Alternative milks are fluids that result from the breakdown (size reduction) of plant material (cereals, pseudo-cereals, legumes, oilseeds, and nuts) extracted in water and further homogenization of such fluids (**Sunidhi *et al.*, 2021**). Although there is no stated definition or classification of these alternative milks in literature, a general classification of the plant-based and vegetable milk alternatives into five categories is attempted, which are as follows, cereal-based, oat milk, rice milk, corn milk, and spelt milk. Legume-based soy milk, peanut milk, lupine milk, and cowpea milk are nut-based, as are almond milk, coconut milk, hazelnut milk, pistachio milk, walnut milk, and cashew milk. Seed-based sesame milk, flax milk, hemp milk, and sunflower milk **(Manzoor *et al*., 2017)**.

There are studies that used vegetable milk to make food products for patients with lactose intolerance, such as using alternative milks in making ice cream, cream caramel, pudding, and rice pudding, and the chemical composition of the alternative milks was similar to cow’s milk. Some studies recommend using alternative milks to make products free of lactose (**Abdallwahab *et al*., 2017**).

Coconut milk can be used in making ice cream, and its chemical composition was similar to that of commercial milk. It also received better sensory acceptance than commercial ice cream. Therefore, the study recommends using coconut milk in ice cream because it is lactose-free **(Merritt *et al.*, 2020**). Yogurt was produced from coconut milk and found to be similar to commercial yogurt, contains a high percentage of fat, and has received sensory acceptance. Therefore, it is recommended to use coconut milk to make yogurt for lactose-intolerant patients *(**Craig*** **and Brothers, 2021**).

This current study aims to use some alternative milks (sesame, cashew, and coconut milk) to make some food products (cream caramel, ice cream, rice pudding, and pudding) suitable for patients with lactose intolerance, determine chemical, mineral, and color parameters, and measure the sensory properties of some products that use these milks**.**

MATERIALS AND METHODS

Materials

1) Raw purchased (sesame-cashew-coconut) from the local market in the nut shop in new Damietta city, Damietta Governorate, Egypt.
2) The standardized milk (cow milk) was obtained from dairy market from new Damietta city, Damietta governorate, Cairo.
3) Ingredents of Vegan dairy products (rice, sugar, vanilla, cream powder, popcorn and eggs obtained from local market, Damietta Governorate, Egypt).
4) Chemical and kits were purchased from Al Gomhouria Company in Cairo.

Methods

Alternative milks preparation

Preparation of sesame milk

Wash 500g sesame seeds with tap water, then soaked in a liter and a half of water for 8 hours at room temperature, then we get rid of the soaking water by filtering it with a cotton cloth and leaving it in gauze for 2 minutes, then calibrated to make sesame milk. And put 1cup sesame seeds: 2 cup water, Water: then grind it in a blender at high speed for 2 minutes, then filter the mixture with a cotton cloth, then treat the milk at 73 °C for 15 minutes, then cool it for 15 minutes, and freezing at -18 °C it cools for an hour **(Abdallwahab *et al.*, 2017).**

Preparation of cashew milk

Wash 500g cashew seeds with tap water, then soaked in a liter and a half of water for 8 hours at room temperature, then we get rid of the soaking water by filtering it with a cotton cloth and leaving it in gauze for 2 minutes, then calibrated to make sesame milk. And put 1cup of cashew size: 4cup of water, then grind it in a blender at high speed for 2 minutes, then filter the mixture with a cotton cloth, then treat the milk at 73 °C for 15 minutes, then cool it for 15 minutes, and freezing at -18 °C it cools for an hour **(Craig and Brothers., 2021),** to prevent microbial growth until used **(Tamuno *et al*., 2019).**

Preparation of coconut milk

Wash 500g coconut seeds with tap water, then soaked in a liter and a half of water for 8 hours at room temperature, and then we get rid of the soaking water by filtering it with a cotton cloth and leaving it in gauze for 2 minutes, then calibrated to make coconut milk. And put 2 cup of coconut size: 4 cup of water,, then grind it in a blender at high speed for 2 minutes, then filter the mixture with a cotton cloth, then treat the milk at 73 °C for 15 minutes, then cool it for 15 minutes, and freezing at -18 °C it cools for an hour **(Amirtha *et al*., 2021).**

Preparation of products using alternative milk

Cream caramel

To prepare the cream ,melt 150gm powdered cream with 120 gm. powdered sugar with 450 ml of cow milk , then add 450gm eggs to the previous mixture and heat it over the fire until completely melted , then add 2.02gm of vanilla ,then replaced the cow milk with(sesame milk , cashew milk and coconut milk)then prepare caramel , first melt 150gm white sugar over a low heat , stirring constantly until caramelized **(protonotariou *et al*., 2013).**

Ice cream:

In the beginning add 100gm of powdered cream to 450gm cow milk, then whisk them ,then added 150gm of powdered sugar to the mixture ,finally added 3gm vanilla then replaced cow milk with (sesame milk, cashew milk and coconut milk) **(Abdallwahab *et al*., 2017).**

Rice pudding

first, soak 150gm of Egyptian rice in 400ml of boiling water, then filter it and put 450ml of cow milk on low heat, then pour rice over it, sweeten it with 120gm white sugar, and put .6gm salt before turn off put .3gm vanilla then replaced cow milk with (sesame milk, cashew milk and coconut milk) .According to **(Saba., 2014)** with modification.

Pudding

At the first heat 450gm over a low heat ,then add 120gm white sugar, add 2gm mastic with 3gm vanilla and add these with 125gm corn starch and dissolve it in the cow milk and stir constantly until consistency ,then replaced cow milk with (sesame milk, cashew milk and coconut milk) **(Dawane *et al.*,2010).**

Table (1): Ingredients of food products using alternative milks

Cream caramel			
Cow milk	Sesame milk	Cashew milk	Coconut milk
450ml cow milk	450g sesame milk	450g cashew milk	450g coconut milk
150g cream powder	150g cream powder	150g cream powder	150g cream powder
120g powder sugar	120g powder sugar	120g powder sugar	120g powder sugar
450g eggs	450g eggs	450g eggs	450g eggs
150g white sugar	150g white sugar	150g white sugar	150g white sugar
2.02g vanilla	2.02g vanilla	2.02g vanilla	2.02g vanilla
Ice cream			
Cow milk	Sesame milk	Cashew milk	Coconut milk
450g cow milk	450g sesame milk	450g cashew milk	450g coconut milk
100g cream powder	100g cream powder	100g cream powder	100g cream powder
150g sugar powder	150g sugar powder	150g sugar powder	150g sugar powder
3g vanilla	3g vanilla	3g vanilla	3g vanilla
Rice pudding			
Cow milk	Sesame milk	Cashew milk	Coconut milk
450g cow milk	450g sesame milk	450g cashew milk	450g coconut milk
150g Egyptian rice	150g Egyptian rice	150g Egyptian rice	150g Egyptian rice
120g white sugar	120g white sugar	120g white sugar	120g white sugar
400ml boiling water	400ml boiling water	400ml boiling water	400ml boiling water
3g vanilla	3g vanilla	3g vanilla	3g vanilla
.6g salt	.6g salt	.6g salt	.6g salt
Pudding			
Cow milk	Sesame milk	Cashew milk	Coconut milk
450g cow milk	450g sesame milk	450g cashew milk	450g coconut milk
125g corn starch	125g corn starch	125g corn starch	125g corn starch
120g white sugar	120g white sugar	120g white sugar	120g white sugar
2g mastic	2g mastic	2g mastic	2g mastic
3g vanilla	3g vanilla	3g vanilla	3g vanilla

Organoleptic characteristics of alternative milks

Alternative milk products were subjected to sensory evaluation using eleven members randomly selected from faculty of specific education, department of home economics. Members judges the products for overall acceptability and sensory attributes color , aroma ,texture , taste .And it was recommended to take sips of water after every sample tasting (**Tamuno and Monday, 2019).**

Chemical analysis

Proximate analysis involving moisture, protein, fat, and ash, crude fibers were carried out according to the methods of **AOAC (2005**) .Carbohydrates content was calculated by difference**.**

Mineral analysis

Mineral analysis of alternative milk used the atomic spectrophotometer (AAS).minerals that were determined included ,sodium (Na), magnesium (Mg),phosphorus(P) ,potassium(K) ,calcium(Ca) ,iron (Fe) , zinc (Zn) (**Kolapo and olubamiwa, 2012).**

Color determination of method

The color of milk samples was measured using a spectrocolorimeter Tristimulus Color Machine with the CIELAB cooler space (International Commission on Illumination). L* (lightness, brightness, or darkness), a* (redness), and b* (yellowness) were used to represent the color values, were calculated according to the method of (**El-Bialy *et al.*, 2020**) the experiments were conducted at the nutrition research institute in Cairo, Egypt.

Statistical analysis

The current results were analyzed statistically using SPSS statistical package (Version 9.05) according to **(Rattanathanalerk *et al.*, 2005)** analysis of variance (ANNOVA),Duncan's multiple range test and least significant difference (LSD)was chosen to determine the significant difference among various treatments .Differences considered significant at $P \leq 0.05$.

Results and discussion

Organoleptic characteristics of products using alternative milks

Data in Table 2 showed the sensory evaluation of some food products using alternative milks. It was observed that cow milk was classified significantly, with the highest scores for color, aroma, texture, taste, and overall acceptability. When using alternative milks in making cream caramel, the sensory properties changed compared with cow milk. There was a high level of acceptance when using alternative milks (sesame milk, cashew milk, and coconut milk). Coconut milk scored the highest value, followed by cow milk, in all sensory properties. It was noted that there were no significant differences between cow milk and coconut milk in making cream caramel in all sensory properties; the lowest value was recorded for sesame milk in making cream caramel; therefore, there were significant differences between sesame milk and control milk in all sensory properties. Therefore, the sensory properties of the product changed after using sesame milk.

Coconut milk scored the highest value after control milk in all sensory properties when making ice cream. It was noted that there were no significant differences between control milk and coconut milk in making ice cream in terms of sensory properties. The lowest value was recorded for sesame milk in making ice cream. Therefore, the sensory properties of the product changed after using sesame milk. It had been observed that cashew milk is close to coconut milk in overall acceptability for ice cream. Coconut milk scored the highest value after control milk in all sensory properties in making ice cream; it was noted that there were no significant differences between control milk and coconut milk in making rice pudding in all sensory properties; the lowest value was recorded for cashew milk in making rice pudding; therefore, there are significant differences between cashew milk and control milk in all sensory properties. Therefore, the sensory properties of the product changed after using the other vegetarian milks. There is no acceptance in taste or aroma when using cashew and sesame milk in rice pudding. Taste is the main factor in the acceptability of products. The best taste in making (cream caramel-ice cream-rice pudding-pudding) was for coconut, and the lowest taste was for sesame milk in making (cream caramel-ice

cream-rice pudding-pudding). It was found that there were no significant differences between (C1, C2-I1, I2-R1, R2-P1, P2) in color, aroma, texture, taste, or overall acceptability.

Coconut milk scored the highest value after control milk in all sensory properties when making pudding. It was noted that there were no significant differences between control milk and coconut milk in making pudding in all sensory properties, and the lowest value was recorded for sesame milk in making pudding. Therefore, there are significant differences between sesame milk and control milk in all sensory properties. There is no acceptance in making pudding using sesame milk it scored low in (aroma, texture, taste, and acceptability. According to **Akeem *et al*. (2018),** the yogurt produced from coconut milk didn't differ from that produced from cow's milk in any sensory properties. And the lowest taste was for sesame milk. In agreement with results reported by **El-Bialy *et al*. (2020),** sesame milk scored a low degree compared with control milk and coconut milk, and according to **Almnura *et al.* (2011),** sesame milk had low values and an unacceptable flavor when making yogurt with sesame milk. It was found that there was a significant difference in taste between cow's milk and cashew milk when making cream caramel and rice pudding. This result agrees with **Manzoor *et al.* (2017),** who found that there were significantly higher differences in taste. Coconut milk had the highest values in all sensory attributes in making all products (cream caramel, ice cream, rice pudding, and pudding). This result agrees with **El-Bialy's *et al.* (2020)** finding that coconut milk had the highest values in all sensory properties (9.3, 9-9.1-9.0-, 8.99-9.2) for color, taste, flavor, mouth feel, texture, and similarity to cow milk.

Table (2): organoleptic characteristic of products using alternative milks

Cream caramel						
Properties	**Color (20scores)**	**Aroma (20scores)**	**Texture (20scores)**	**Taste (20scores)**	**Overall Acceptability (20scores)**	**Total (100score)**
C1	**19.5±0.82^{a}**	**19.3±1.10^{a}**	**19.1±1.10^{a}**	**19.3±1.10^{a}**	**19.6±0.80^{a}**	**95.2±7.70^{a}**
C2	**18.8±1.72^{a}**	**18.1±1.20^{a}**	**18.09±1.30^{a}**	**18.6±1.30^{a}**	**18.2±1.01^{a}**	**92.09±5.60^{a}**
C3	**17.9±1.90^{c}**	**17.4±1.10^{b}**	**15.8±2.40^{c}**	**16.6±1.80^{c}**	**17±1.90^{c}**	**84.8±7.50^{c}**
S4	**18.0±2.30^{b}**	**17.1±2.08^{c}**	**17.3±2.20^{b}**	**16.9±2.30^{b}**	**17.2±2.20^{b}**	**86.6±10.10^{b}**
ICE CREAM						
Properties	**Color (20scores)**	**Aroma (20scores)**	**Texture (20scores)**	**Taste (20scores)**	**Overall Acceptability (20scores)**	**Total (100score)**
I1	**19.4±1.03^{a}**	**18.9±1.20^{a}**	**19.6±0.67^{a}**	**19.1±1.16^{a}**	**19.09±0.94^{a}**	**96.4±3.50^{a}**
I2	**19.1±0.87^{a}**	**18.7±1.20^{a}**	**19.09±.94^{a}**	**18.3±1.80^{a}**	**19.0±0.89^{a}**	**94.2±5.60^{a}**
I3	**18.9±0.90^{a}**	**18.6±0.67^{a}**	**18.09±1.44^{b}**	**18.3±0.92^{a}**	**18.5±0.68^{a}**	**92.5±3.50^{a}**
I4	**18.6±0.80^{b}**	**17.2±1.70^{b}**	**18.1±1.16^{c}**	**16.8±1.70^{b}**	**17.6±1.90^{b}**	**88.1±5.80^{b}**
RICE PUDDING						
Properties	**Color (20scores)**	**Aroma (20scores)**	**Texture (20scores)**	**Taste (20scores)**	**Overall Acceptability (20scores)**	**Total (100score)**
R1	**19.5±0.82^{a}**	**19.1±1.07^{a}**	**19.09±1.13^{a}**	**19 ±1.30^{a}**	**19.09±1.44^{a}**	**95.09±6.30^{a}**
R2	**18.9±1.30^{a}**	**18.6±1.60^{a}**	**17.9±2.07^{a}**	**18.1±1.99^{a}**	**19.09±1.44^{a}**	**92±8.20^{a}**
R3	**18.09±1.80^{c}**	**16.7±1.19^{c}**	**17±1.40^{c}**	**16.3±2.10^{c}**	**16.8±2.04^{b}**	**85±6.60^{c}**
R4	**18.1±1.40^{b}**	**17.09±1.50^{b}**	**17.1±1.16^{b}**	**16.7±1.50^{b}**	**16.8±2.04^{b}**	**89.0±7.90^{b}**
PUDDING						
Properties	**Color (20scores)**	**Aroma (20scores)**	**Texture (20scores)**	**Taste (20scores)**	**Overall Acceptability (20scores)**	**Total (100score)**
P1	**19.2±1.10^{a}**	**18.9±1.10^{a}**	**17.8±1.99^{a}**	**18.09±1.86^{a}**	**18.3±,1.50^{a}**	**92.6±6.90^{a}**
P2	**18.8±0.98^{a}**	**19.0±1.00^{a}**	**18.1±1.07^{a}**	**18.5±0.82^{a}**	**18.6±0.67^{a}**	**91.8±6.10^{a}**
P3	**18.1±0.60^{b}**	**18±0.44^{b}**	**17.3±1.70^{a}**	**17.3±1.20^{b}**	**17.8±0.75^{a}**	**87.8±2.10^{b}**
P4	**17.8±1.40^{c}**	**16.6±1.20^{c}**	**16.4±1.12^{b}**	**15.2±1.19^{c}**	**16.6±1.50^{b}**	**82±4.50^{c}**

Different superscript letters in the same column indicate a significant ($p \leq 0.05$) difference according to Duncan's test

C1,I1, R1 and P1 = cow milk ,C2,I2,R2 and P2=coconut milk , C3,I3,R3 and P3 =cashew milk , C4,I4,R4 and P4 = sesame milk.

Chemical Analysis of alternative milks

Data in table (3) demonstrated the chemical composition of alternative milks. The moisture content of sesame milk was 88.16%, which is higher than control milk's 86.84%, this result was lower than cashew milk's 86.46% and coconut milk's 81.85%. According to the fat content of coconut milk, it was 4.72%, which is higher than control milk's 4.09%, compared with sesame milk's 3.42% and cashew milk's 3.13%. According to the ash content of coconut milk, it was 1.34%, which is higher than control milk (.71%), sesame milk (44%), and cashew milk (32%). Beside this, the fiber content of sesame milk was 2.16%, and this result was lower than cashew milk's 0.35% and coconut milk's 0.09%, as the percentage of fiber in the control milk is almost non-existent. According to the protein content of coconut milk, it was 3.41%, which is near control milk's 3.61%. This result was higher than cashew milk's 3.08% and lower than sesame milk's 2.57%. In this respect, the carbohydrate content of cashew milk was 6.66%, which is higher than control milk's 4.75%, compared with sesame milk's 3.25% and coconut milk's 4.11%. Also, there was an increase in the percentage of moisture, fat, ash, fiber, and carbohydrate in alternative milks and a decrease in the percentage of protein. In this regard, the high content of moisture was in sesame milk, and this result chimes with **Abdallwahab *et al*. (2017)**, who report that the percentage of moisture was 86%. The highest percentage of fat is found in coconut milk, which, as they reported, has a higher level of fat than cow's milk. There were significant differences in fat between cow's milk and coconut milk. In this regard, the highest percentage of ash is found in coconut milk, and this result differs from that reported by **Akoma *et al.* (2000),** who reported coconut milk had ash levels lower than cow milk. In this regard, we find that the highest percentage of fiber was in sesame milk, and this result differs from the report by **Abdallwahab *et al.* (2017),** which had the highest content of fiber compared with cow milk. In this regard, we find that the highest percentage of protein is found in coconut milk, and this result is similar to the report by **Kolapo and Olubamiwa (2012),** which reported a lower percentage of protein than cow milk. There were no significant differences in protein between control

milk and coconut milk. In this regard, we find that the highest percentage of carbohydrates is found in cashew milk, and this result is similar to the report by **Gasmalla *et al.* (2013)**, which reported a higher percentage of carbohydrates than cow milk. According to carbohydrate content, there were significant differences between alternative milks and cow's milk.

Table (3) chemical composition of alternative milks.

Samples	Chemical composition (%)					
	Moisture%	Fat%	Ash%	Fiber%	Protein%	Total carbohydrate%
Cow Milk	86.84±.10^{b}	4.09±.10^{b}	0.71±.10^{a}	ND	3.61±.10^{a}	4.75±.10^{b}
Sesame milk	88.16±.15^{a}	3.42±.15^{c}	0.44±.15^{b}	2.16±.15^{a}	2.57±.15^{c}	3.25±.15^{d}
Cashew milk	86.46±.05^{a}	3.13±.05^{d}	0.32±.05^{c}	0.35±.05^{b}	3.08±.05^{b}	6.66±.05^{a}
Coconut milk	81.85±.10^{d}	4.72±.10^{a}	1.34±.10^{a}	0.09±.10^{c}	3.41±.10^{a}	4.11±.10^{c}

Different superscript letters in the same column indicate a significant ($p \leq 0.05$) difference according to Duncan's test.

Mineral content of alternative milk

Data in Table (4) showed that the mineral content of alternative plant-based milk was richer in elements compared with cow milk. the highest content of sodium was for sesame milk (36.97mg/100ml)after cow milk (49.25mg\100ml) but the lowest content was for cashew milk (4.88 mg/100ml), the highest content of magnesium was for coconut milk (60.15 mg/100ml) but the lowest content was for sesame milk (1.41 mg/100ml),the highest content of phosphate was for cow milk (93.81 mg/100ml),but the lowest content was for coconut milk (1.80 mg/100ml), the highest content of potassium was cashew milk (194.43 mg/100ml) but the lowest content was for coconut milk(14.90 mg/100ml) The highest content of calcium was in sesame milk (147.34 mg/100 ml), but the lowest content was in coconut milk (8.79 mg/100 ml). The highest content of iron was in cashew milk (2.97 mg/100 ml), but the lowest content was in cow milk (0.06 mg/100 ml). The highest content of zinc was in cashew milk (0.91 mg/100 ml). The lowest content was for coconut milk (0.12 mg/100 ml). In this

regard, we found that sesame milk contains less sodium than control milk these results agree with **El-Bialy *et al.* (2020).** In this regard, we find that coconut milk is the highest type of milk containing magnesium. This result agrees with the result reported by **Belewu *et al.* (2013).** In this regard, it becomes clear to us that the most phosphorus-containing type of milk is cashew milk, but it is lower than cow's milk. The highest percentage of milk containing potassium is higher in cashew milk, and these results contradict the report by **Manzor *et al.* (2017).** The most rich type of milk in calcium is sesame milk, more than control milk and other milks, and these results agree with **El-Bialy *et al.* (2020)**. In this regard, we find that the most common type of milk that contains zinc and iron is cashew milk. This report agrees with these findings by **El-Bialy *et al.* (2020).**

Table (4) Minerals content of alternative milks

Samples	Minerals content (mg/ 100 mL)						
	Sodium	Magnesium	Phosphate	Potassium	Calcium	Iron	Zinc
Cow Milk	49.25±0.10^{a}	9.92±0.10^{c}	93.81±0.10^{a}	142.25±0.10^{b}	133.39±0.10^{b}	0.06±0.10^{d}	0.48±0.10^{b}
Sesame milk	36.97±0.15^{b}	1.41±0.15^{d}	25.18±0.15^{b}	117.98±0.15^{c}	147.34±0.15^{a}	1.57±0.15^{b}	0.77±0.15^{b}
Cashew milk	4.88±.05^{d}	44.34±0.05^{b}	88.15±0.05^{b}	194.43±0.05^{a}	16.48±0.05^{c}	2.97±0.05^{a}	0.91±0.05^{a}
Coconut milk	13.63±0.10^{c}	60.15±0.10^{a}	1.80±0.10^{c}	14.90±0.10^{d}	8.79±0.10^{d}	0.13±0.10^{c}	0.12±0.10^{c}

Different superscript letters in the same column indicate a significant (p≤0.05) difference according to Duncan's test.Different superscript letters in the same column indicate a significant (p≤0.05) difference according to Duncan's test

Color measurements of alternative milks

Data in table (4) demonstrated the color measurements of alternative milk. Results in table (4) showed the color measurement values (L*, a*, and b*) of alternative milk. From the results presented in the same table, it could be noticed that the highest values of crust lightness (L*values) were coconut milk (93.73), followed by cow milk (93.01), and cashew milk (81.10). the lowest vales of crust lightness in sesame milk(77.06). It was observed that there were significant differences between cow's milk and alternative milk (sesame milk, cashew milk, and coconut milk). Concerning the redness (a*) of color

parameters in alternative milks, the highest values were recorded for sesame milk(2.23) after cow milk, followed by cashew milk (1.09). The lowest value of redness in coconut milk (-2.03), compared with cow milk (-1.52). For the yellowness (b*), it recorded the highest value of coconut milk (212.27) compared with control milk (10.01), and the lowest value of crust yellowness in cashew milk (10.01). 13.88. In this regard, it was found that coconut milk has a high L* (93.73), and this result converges with the result reported by **El-Bially *et al.* (2020).** It found that lightness was higher when increasing the fat content. Fat can raise the dispersion and reflectance of light **(Suri *et al*., 2019).** On the other hand, sesame milk had a high a* (2.23), and this result contradicts the report by **El-Bially *et al*. (2020).** In this regard, we find that coconut milk has a high b* (212.27), and this result agrees with **El-Bially *et al*. (2020)**.

Table (4) Color measurements of alternative milks

Samples	Color parameters		
	L*	a*	b*
Cow Milk	**93.01±.10a**	**-1.52±.10c**	**10.01±.10d**
Sesame milk	**77.06±.15d**	**2.23±.15a**	**16.83±.15b**
Cashew milk	**81.10±.050c**	**1.09±.050b**	**13.88±.050c**
Coconut milk	**93.73±.10b**	**-2.03±.10d**	**212.27±.10a**

Different superscript letters in the same column indicate a significant ($p \leq 0.05$) difference according to Duncan's test.Different superscript letters in the same column indicate a significant ($p \leq 0.05$) difference according to Duncan's test

L*=lightness, a*=redness, b*=yellowness

Conclusion

In conclusion, sesame milk, coconut milk, and cashew milk products can be used for patients with lactose intolerance. Products with coconut milk had the highest acceptability compared with other alternative milks. So in future studies, these samples will be combined at different levels to produce new alternative milk with high nutritional value and acceptable sensory properties. We recommended using alternative milk (sesame milk, cashew milk, and coconut milk) because of its low cost and lactose-free nature. Products made from coconut milk showed a high degree of acceptance from sensory properties, the values were close to those of cow's milk, followed by cashew milk. Sesame milk had the lowest acceptance value compared with other alternative milks.

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عمل بعض الألبان البديلة واستخدامها في اعداد منتجات غذائية تناسب مرضي حساسية اللاكتوز

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الملخص

حساسية اللاكتوز هي رد فعل الجهاز الهضمي في عدم تقبل الاكتوز الموجود باللبن حيث يسبب أعراض مؤلمة بعد تناول منتجات الألبان لذا هدفت الدراسة الحالية الي تصنيع واستخدام بعض الألبان النباتية في اعداد منتجات غذائية تناسب مرضي حساسية اللاكتوز ولهذا الغرض تم اعداد أربعة منتجات غذائية (كريم كراميل–أيس كريم –أرز باللبن–بودنج)باستخدام ثلاثة أنواع من الألبان النباتية (لبن السمسم–لبن الكاجو–لبن جوز الهند) وتم عمل تقييم حسي للمنتجات بالاضافة الي دراسة التركيب الكيميائي والمعدني والقياسات اللونية للألبان البديلة ومقارنتها باللبن البقري وقد أظهرت نتائج التقييم الحسي وجود درجة تقبل عالية للمنتجات المسنخدم بها الألبان البديلة محل الدراسة كما حصلت المنتجات التي استخدم في اعدادها لبن جوز الهند علي أعلي الدرجات بعد اللبن البقري. هذا وقد أظهرت دراسة التركيب الكيميائي احتواء حليب جوز الهند علي أعلي نسبة دهون ورماد مقارنة بأنواع الألبان الأخري بينما احتوي لبن السمسم علي أعلي نسبة ألياف أما لبن الكاجو فقد احتوي علي أعلي نسبة كربوهيدرات وبالنسبة لنتائج القياسات اللونية أظهرت وجود فروق ذات دلالة معنوية بين كلا من الالبان النباتية المستخدمة واللبن البقري وذلك عند مستوي معنوية أقل من ٠,٠٥ لذا توصي الدراسة باستخدام حليب السمسم وحليب الكاجو وحليب جوز الهند في اعداد الوجبات الخاصة بمرضي حساسية اللاكتوز .

الكلمات المفتاحية: الألبان البديلة ، حساسية اللاكتوز ، الخصائص الكيميائية ، القياسات اللونية ، الخصائص الحسية