

Formulation and Evaluation of Some Novel Food Products Containing Plant (Vegan) Milks

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ABSTRACT

Some plant (vegan) milks were prepared, namely brown rice milk, coconut milk and almond milk. Moreover, strawberry fermented milk, and non-fermented milk, chocolate pudding and spreadable cheddar cheese were made. Chemical composition revealed that almond milk possessed significantly ($P \leq 0.05$) the highest protein content (6.1%) on contrary to coconut milk being the significantly ($P \leq 0.05$) lowest content (2.3%). Meanwhile, almond and milk exhibited significantly ($P \leq 0.05$) the highest contents of each of the following mineral elements: potassium, calcium, zinc and magnesium. Sensory evaluation indicated that strawberry milk made from almond milk and coconut milk were superior in acceptability by panelists in contrast, strawberry milk made from cow's milk was ranked significantly ($P \leq 0.05$) as the least acceptable. The most favorable sensorial properties were figured out for strawberry milk +50% coconut milk stored for one day. Generally, the best sensorial properties for cheddar cheese were traced for samples made from 70% rice milk +30% almond milk.

Keywords: Cow's milk, rice milk, coconut milk, almond milk, fermented milk, spreadable Cheddar cheese, chocolate pudding, Sensory evaluation.

INTRODUCTION

In Western countries, plant-based milk food products are well known. Such products have health benefits for persons suffering from lactose intolerance or those who are allergic to milk proteins. Meanwhile, plant sources are considered as functional foods owing to presence of health promoting compounds such as dietary fibers, minerals, vitamins and antioxidants (Lee, 2014).

Consumption of dairy products has been reported to decline since 1970. Such a trend is related to consumers desire for healthier and more environmentally friendly (Schott & Bernard, 2015, Mäkinen *et al.*, 2016). Theoretically, plant milks are defined as water extracts of legumes, oil seeds, cereals or pseudo cereals that resemble cow milk in appearance (Mäkinen *et al.*, 2016). Consequently, many plant sources (soy beans, almonds, coconut and rice can be utilized for formulating non-dairy products. it is worth to mention that the most current dietary guidelines 2015-2020 recognized soy milk as a part of the dairy group due to its similarity in nutrition to cow milk (USDA, 2013).

It is worth to mention that a number of consumers are opting for plant-based milk alternatives for dietary restrictions such as vegetarian vegan diet or those with medical conditions such as lactose intolerance, which affects 75% of the worldwide population, are replacing traditional cow milk for a plant-based substitute (Mäkinen *et al.*, 2016).

The present study was carried out to prepare and evaluate different types of plant milks (Vegan milk) from coconut, almonds and rice grains. Moreover, some food products were prepared using the aforementioned plant milks. These food products were evaluated from physicochemical and sensorial points of view.

MATERIALS AND METHODS

Materials:

Raw materials were purchased from the local market, Alexandria, Egypt. Flavouring agents were obtained from AWA Company Borg Al-Arab, Alexandria, Egypt. Probiotics were obtained from Protexin Health Care Company, United Kingdom.

Preparation of plant (Vegan) milks:

Brown rice milk, coconut milk and almond milk were formulated as shown in Table (1) Ingredients of plant milk formulation :

Table 1: Formulation of vegan milks

Ingredients	Brown rice milk	Coconut milk	Almond milk
	Wight	Wight	Wight
Raw material (g)	200	200	200
Filtered water (ml)	1000	800	800
Vanillin (g)	1	1	1
Maple syrup (g)	3	3	3
Salt (g)	1	1	1

Preparation of food products containing plant milks:

Strawberry flavoured plant milks:

Four types of milk (skimmed cow's milk, rice milk, coconut milk and almond milk) were formulated as shown in Table (2)

Strawberry flavour was added to each of the plant milk used in the present study. Thereafter, the milk was heated at 90°C for 10 min, followed by storage for 14 days at 4°C

Chocolate pudding

The four types of milk (skimmed milk, rice milk, coconut milk and almond milk) were prepared then sugar and chocolate pudding powder were added to each of milk preparation. Each sample was heated at 90°C for 10 min. The mixture was stored at (4°C) for different stronge periods.

Strawberry fermented milk

It was consisted of four recipes

- 100% brown rice milk
- 90% brown rice milk + 10% coconut milk

- 70% brown rice milk + 30% coconut milk
- 50% brown rice milk + 50% coconut milk

Vanillin, sugar and carrageenan were added to each sample, all samples were heated at 90°C for 20 min. After cooling, the probiotic and strawberry syrup were added to each sample. Finally samples were poured into sterilized bottles and were incubated at 42°C for 7 hr , then stored at 4°C for different storage periods.

Spreadable cheddar cheese

It was consisted of four recipes

- 100% brown rice milk
- 90% brown rice milk + 10% almond milk
- 70% brown rice milk + 30% almond milk
- 50% brown rice milk + 50% almond milk

Starch, salt, coconut oil, carrageenan, cheese flavour and natural colour were added to each sample. Each sample was heated at 90°C for 10 min. It was stored for 14 days at 4°C.

Analytical methods:

Physical methods:

Viscosity measurement

Viscosity of plant milks and formulated food products was measured by digital rotary Viscometers MYR (VR 300- Model L, Viscotech Hispania S.L, El Vendrell, Spain). According to Nilsson *et al.* (2006).

Colour measurement:

Colour of plant milks and formulated food products was measured by Hunter high performance spectrophotometer (UltraScan® , Hunter Associates Laboratory Inc., Va, USA).The tristimuls values for colour namely: L*, a* and b* were measured where: L*: represents darkness from black (0) to white (100), a*represents colour ranging from red (+) to green (-) and b* represents yellow (+) to blue (-) .

Texture profile:

The texture profile analysis was carried out on fresh samples of Cheddar spread cheese and chocolate pudding. Wasused Texture analyzer (model TA1000, Lab Pro (FTC TMS-Pro, USA) was used as outlined by the International Dairy Federation (1991). The following parameters were evaluated :

Table 2 : Ingredients of strawberry flavoured cow's and plant milks

Ingredients	Skimmed milk	Rice milk	Coconut milk	Almond milk
Milk (ml)	1000	1000	1000	1000
Strawberry Syrup (g)	30	30	30	30
Frozen strawberries (g)	20	20	20	20
Vanillin (g)	2	2	2	2
maple syrup (g)	3	3	3	3

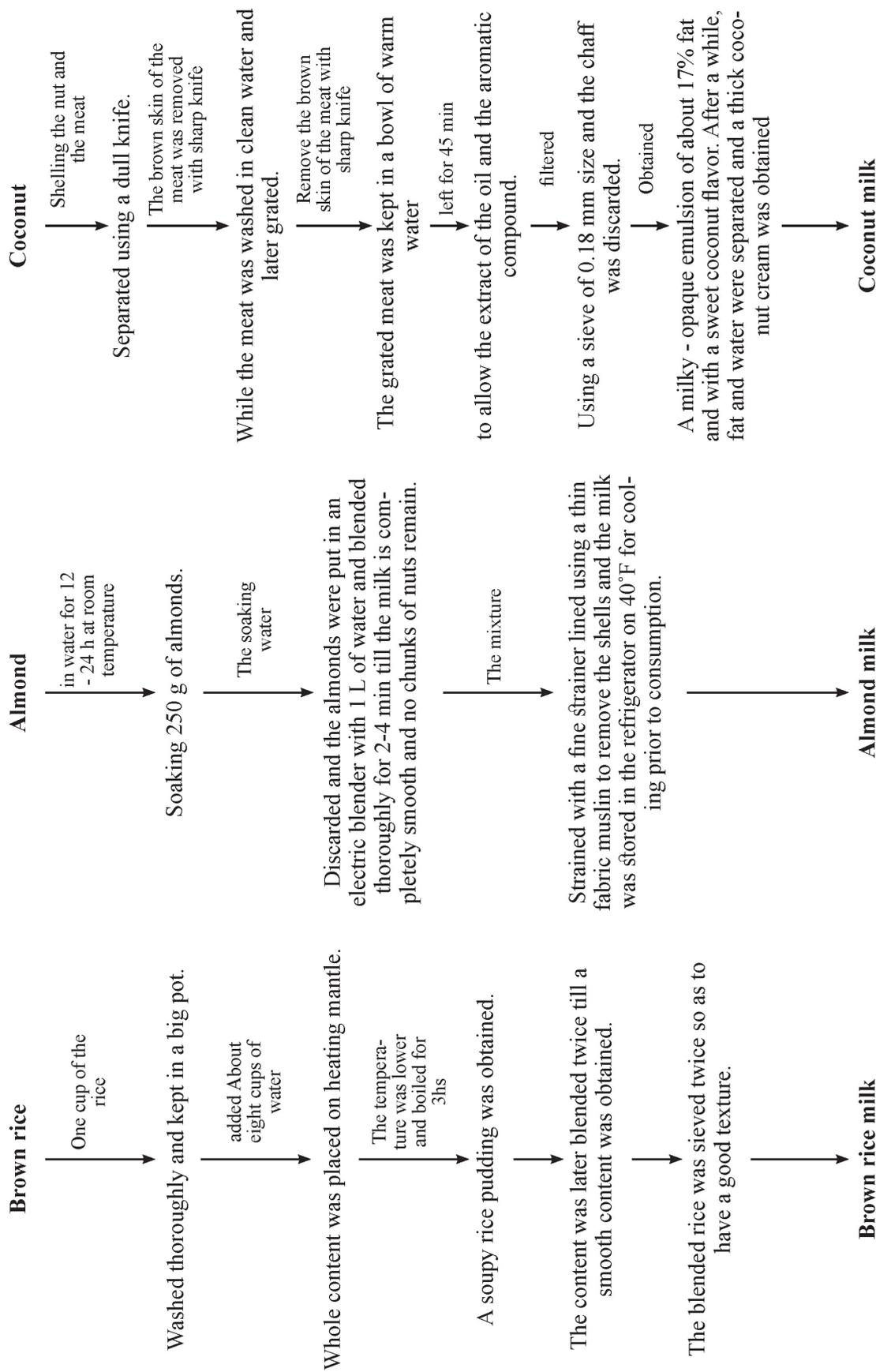


Fig. 1: Flow sheets showing preparation of different plant milks

- Hardness (kilogram, g): the force required to produce a given deformation,
- Springiness (mm): the rate at which a deformed material goes back to its undeformed condition after the deforming force is removed,
- Gumminess (g): the quantity to simulate the energy required to disintegrate a semi-solid food product to a state ready to swallowing, (Gumminess= hardness × cohesiveness) and
- Chewiness (mi): the quantity to simulate the energy required to masticate a solid food product to a state ready for swallowing, (chewiness= gumminess x springiness)

Chemical methods:

Gross chemical composition of milk and vegan milk was determined according to the AOAC (2006). Dietary fiber was determined using an ANKOM 220 fiber analyzer according to AOAC (2006).

The pH of milk and vegan milk was measured by digital pH meter (Basic20 PH-Meter; Crison Instruments, Barcelona, EU).

Starch content of milk and vegan milk was determined spectrophotometrically (thermoscientific, MESLO company, Egypt according to AOAC (2006). Mineral elements were determined according to AOAC method (2006) by Atomic Absorption Spectrophotometer (Thermo Scientific, MESLO Company, Cairo, Egypt)

Sensory evaluation:

Organoleptic properties were assessed for fresh samples and stored samples for 7 and 14 days as described by Tamime *et al.* (2006). The panel group consisted of ten panelists from staff members and postgraduate students, Department of Dairy Science and Technology, Faculty of Agriculture, University of Alexandria.

Microbiological assay:

The microbiological analysis of different vegan products were carried out according to IDF Standard method 122 C (1996). The total viable bacterial counts were enumerated on plate count agar medium at 32°C for 48 h as described by Harrigan and McCance (1976).

Yoghurt samples were tenfold serially diluted in 0.15% sterile peptone water. Using drop plate

method, 20 µl of each dilution was plated in triplicate on selective media as described by Kleessen *et al.* (1997). *S. thermophilus* was enumerated on *S. thermophilus* agar medium (ST agar) and incubated aerobically at 37°C for 24hr. *Lb. bulgaricus* was counted on MRS adjusted to pH 5.2 and incubated anaerobically at 45°C for 72h. *B. lactis* was enumerated on MRS agar and incubated anaerobically at 37°C for 72 hr.

Coliform bacteria were determined using violet red bile agar medium after incubation at 37°C for 24 hr (Harrigan *et al.*, 1976). Counts of aerobic spore forming bacteria were determined on nutrient agar medium at 37°C (Wehr *et al.*, 2004). Molds and yeasts were enumerated on potato dextrose agar medium and plates were incubated at 25±2°C for 5 days (International Dairy Federation, 1991).

Statistical analysis:

The data were statistically analyzed by one-way ANOVA according to SAS statistical software. The significant differences among means were assessed by Duncan's multiple range test (Duncan, 1955).

RESULT AND DISCUSSION

Physicochemical properties of Vegan milks:

The data presented in Table (3) show the physicochemical properties of brown rice milk (BRM), coconut milk (CM) and almond milk (AM). Total solids varied from 21.8% to 22.98%. It was obvious that CM possessed the significantly ($P \leq 0.05$) highest total solids as compared to BRM and AM. The AM had the significantly ($P \leq 0.05$) highest crude protein content (6.10%) on contrary to CM which exhibited the significantly least ($P \leq 0.05$) crude protein content being 2-3%, while BRM had value of (4.66%). (Table 3).

Crude fat revealed a wide range of variation (0.77-12.80%) in the three vegan milks under study. The CM had the significantly highest ($P \leq 0.05$) crude fat content (12.80%) while BRM exhibited the significantly ($P \leq 0.05$) lowest content (0.77%). Table (3) shows that BRM had the significantly ($P \leq 0.05$) total carbohydrate content (3.2%) while CM and AM were quite comparable in this regard since both had 5.6%. Dietary fiber content ranged from 2.2% (CM) to 2.9% (AM), while BRM had 2.70% dietary fiber (Table 3).

Table 3: Physicochemical properties of some vegan milks (BRM, CM and AM)

Parameters (%)	BRM	CM	AM
Total Solids	21.80 ^c	22.98 ^a	22.70 ^b
Crude Protein	4.66 ^b	2.30 ^c	6.10 ^a
Total Fat	0.77 ^c	12.80 ^a	7.20 ^b
Total Carbohydrate%	13.20 ^a	5.50 ^b	5.60 ^b
Dietary Fiber	2.70 ^b	2.20 ^c	2.90 ^a
Starch	0.47	0.01	0.03
Ash	0.11	0.18	0.87
Acidity	0.11	0.17	0.14
pH	6.74	6.71	6.30

BRM= Brown Rice milk, CM = Coconut Milk, AM = Almond milk

Table (3) shows that BRM, CM, and AM varied in terms of their contents of starch (0.01-0.47%), ash (0.11-0.87) and acidity (0.11-0.17%). Moreover, the aforementioned milks varied in their pH values being in a range from 6.30 (AM) to 6.74 (BRM).

The data presented here regarding the investigated physicochemical properties of the three vegan milks are in agreement with numerous published data (Kolapo *et al.*, 2012).

Mineral composition of vegan milks:

Table (4) shows the mineral composition of the three vegan milks under study (BRM, CM and AM). It was clear that CM had the significantly highest ($P \leq 0.05$) contents of six out of ten elements that were determined. Notwithstanding, AM exhibited significantly ($P \leq 0.05$) the highest values for calcium (60.6 mg/100g), phosphorus (134 mg/100 g) and potassium (192mg/100g). The point of interest is that these figures are extremely higher than those belonging to both BRM and CM. The data presented here are in accordance with data published elsewhere (Kartz *et al.*, 2014).

Colour of raw materials and vegan milks

Colour measured by Hunter instrument (Table 5) revealed that brightness (L^*) for rice, coconut and almond ranged between 61.24 (rice milk) and 83.40 (coconut milk) almond while L^* value of 80.97. Table (5) shows that the three straw vegan milks had L^* value ranged between 45.33 and 54.19 as compared to strawberry cow's milk being 54.48. On the other hand, blends of BRM and CM exhibited L^* value ranged from 68.48 (90% BRM + 10% CM) to 70.19 (50% BRM + 50% CM).

Table 4: Mineral composition (mg/100 ml) of some vegan milks (BRM, CM and AM)

Minerals	BRM	CM	AM
Phosphorus	92.2 ^c	100 ^b	134 ^a
Magnesium	11.6 ^c	37 ^b	77 ^a
Potassium	11.3 ^c	263 ^a	192 ^b
Calcium	2.6 ^c	16 ^b	60.6 ^a
Sodium	1.3 ^c	15 ^a	7.8 ^b
Iron	0.1 ^c	1.6 ^a	1 ^b
Zinc	0.2 ^c	0.7 ^b	0.9 ^a
Manganese	0.3 ^c	0.9 ^a	0.6 ^b
Copper	0.0 ^b	0.3 ^a	0.3 ^a

BRM= Brown Rice milk, CM = Coconut Milk, AM = Almond milk

Super scrip letters following numbers in the same row demote significant differences ($P \leq 0.05$)

Table 5: Colour measurements of raw materials and vegan milks as compared to cow's milk

Samples	Colour		
	L^*1	a^*2	b^*3
Cow's milk	82.47	1.72	6.72
Rice milk	61.24	-2.86	1.69
Coconut milk	83.40	-0.97	1.14
Almond milk	80.97	1.66	7.67
strawberry Cow's milk	54.48	19.04	0.39
strawberry Rice milk	45.33	23.88	-1.72
strawberry Coconut milk	54.19	20.43	1.79
strawberry Almond milk	59.41	20.21	-1.12
100% Rice milk	63.27	10.37	3.07
90% Rice milk+ 10% Coconut milk	68.48	10.38	2.47
70% Rice milk+ 30% Coconut milk	68.77	10.71	1.71
50% Rice milk+ 50% Coconut milk	70.19	10.94	1.46

1 L^ : lightness, *2: a^* : redness and *3 b^* : yellowness

Redness value (a^*) ranged from -2.86 for rice to 1.72 for cow's milk. Strawberry cow's milk had the least a^* value being 19.04 on contrary to the strawberry rice milk values (23.88). It is worth to note that a^* values for BRM and its blends with CM were quite comparable (Table 5).

The yellowness value (b^*) ranged between 1.14 (cocoanut milk) and 7.67 (almond milk) for the raw materials used in the present study (Table 5). Not with standing, b^* values ranged from -1.72 (strawberry BRM) to 1.79 (straw CM). Table (5) shows that b^* ranged from 1.46 (blend of 50% BRM + 50% CM) to 3.07 (100% BRM).

Texture of some products made from cow's milk versus vegan milk

Chocolate pudding and Cheddar cheese were made from cow's milk versus some vegan milks and their blends. The data in Table (6) showed that the texture parameters of these products was obvious that pudding made from BRM exhibited the significantly ($P \leq 0.05$) highest values of the textural parameters (hardness, adhesiveness, springiness, gumminess and chewiness). In contrast, pudding made from AM had the significantly ($P \leq 0.05$) least value of hardness. Such a low value for hardness indicates possible difficulties in terms of handling and transportation of pudding made from AM.

In the present study, Cheddar cheese was made from BRM blends mixed with Am at different ratios. Assessment of texture for these samples revealed considerable variation in terms of hardness from 530g (50% BRM + 50% AM) to 641g (for 100% BRM) as shown in Table (6).

Adhesiveness ranged from 7.3 mj (50% BRM + 50% AM) to 11 mj (100% BRM), while springiness ranged between 4.02 mm (50% BRM + 50%

AM) to 5.48 mm (100% BRM). Regarding gumminess, it ranged from 168g (50% BRM + 50% AM) to 206g (100% BRM). On the other hand, Cheddar cheese made from 100% BRM exhibited the highest chewiness value being 7.6 mj, while cheese made from (50% BRM + 50% AM) explored the least chewiness value (3.1mj) as shown in Table (6).

The pH and viscosity of some food products made from vegan milks

Four different food products were made from two vegan milks investigated in the present study (BRM and CM). Such products included strawberry flavoured milk, strawberry fermented milk, chocolate pudding and Cheddar cheese.

The pH values were significantly ($P \leq 0.05$) different and ranged from 6.60 (AM) to rice (6.74). On the other hand, strawberry flavoured milk exhibited pH values ranged from 5.03 (BRM) to 6.23 (cow's milk) as shown in Table (7). The pH values ranged between 4.0 for strawberry fermented milk made from 100% BRM to 4.73 for blend made from 50% BRM + 50% CM (Table 7).

Table (7) shows that the pH values ranged from 6.63 for chocolate pudding made from CM to 8.04 for pudding made from 100% AM. Cheddar cheese made from 100% BRM along with that made from 90% BRM + CM had significantly ($P \leq 0.05$) least pH value (6.81) as shown in Table (7).

Viscosity (MPa) varied from 4.0 to 5.0 for cow's milk, rice milk coconut and almond milks.

Table 6: Texture of chocolate pudding and Cheddar cheese made from cow's milk and different vegan milk

	Samples	Texture				
		Hardness (g)	Adhesiveness (mj)	Springiness (mm)	Gumminess (g)	Chewiness (mj)
chocolate pudding	Cow's milk	330 ^c	6.0 ^d	2.48 ^c	172 ^c	4.2 ^c
	Rice milk	389 ^a	7.3 ^a	3.18 ^a	181 ^a	5.1 ^a
	Coconut milk	343 ^b	6.6 ^b	2.97 ^b	170 ^d	3.7 ^d
	Almond milk	301 ^d	6.5 ^c	2.3 ^d	174 ^b	4.3 ^b
Cheddar cheese	100 rice milk	641	11.0	5.48	206	7.6
	100%rice milk + 10% almond milk	571	10.7	5.14	198	6.4
	70%rice milk + 30% almond milk	557	8.8	4.76	183	5.3
	50%rice milk + 50% almond milk	530	7.3	4.02	168	3.1

Super scrip letters following numbers in the same columns demote significant differences ($P \leq 0.05$)

Strawberry flavoured milk exhibited viscosity values MPA ranged from 7 (AM) to 20 MPA (BRM). On the other hand, values ranged between 15 MPA (50% BRM) and 20 MPA (100% BRM) were recorded for strawberry fermented milk (Table 7).

As shown in Table (7) viscosity of chocolate pudding ranged between 5860 MPA (AM) and 5890 MPA (cow's milk). Notwithstanding, viscosity values ranged between 1430 and 1590 MPA, were recorded for Cheddar cheese made from (50% BRM + 50% CM) blend and cheese made from 100% BRM, respectively.

Sensorial properties of products made from vegan milk

The sensorial evaluation shown in Table (8) indicates that scores given by panelists were significantly ($P \leq 0.05$) different for vegan milks and their products. Almond milk in the strawberry blend of (50% rice milk + 50% coconut milk) in the strawberry fermented milk. Also, the blends of (70% rice milk + 30% almond milk) and (50% rice

milk + 50% almond milk) in the Cheddar cheese and cow's milk in the chocolate pudding have been ranked as superior in terms of colour.

Regarding the scores given for the taste by the panelists, it was obvious that the significantly ($P \leq 0.05$) highest scores were given for each of the following: the strawberry flavoured milk containing rice milk and almond milk. The highest scores were given for the three blends of the strawberry fermented milk (50% rice milk + 50% coconut milk), (70% rice milk + 30% coconut milk) and (90% rice milk + 10% coconut milk). Meanwhile for the Cheddar, cheese, the blend of (50% rice milk + 50% almond milk) and (70% rice milk + 30% almond milk) (Table 8).

The data given in Table (8), indicate that panelists gave the significantly ($P \leq 0.05$) highest scores to odour for coconut milk and almond milk for the strawberry fermented milk it was the blend of milk 50%rice milk +50%coconut milk, for strawberry flavoured milk, while for the chocolate pudding it was cow's milk and no significantly ($P \leq 0.05$) dif-

Table 7: The pH and viscosity during refrigerated storage of vegan milks

	Samples	pH	Viscosity (MPA)
Milk	Cow's milk	6.65±0.07 ^d	5±0.0 ^e
	Rice milk	6.74±0.045 ^e	5±0.0 ^e
	Coconut milk	6.34±0.024 ^e	4±0.0 ^f
	Almond milk	6.6±0.039 ^d	4±0.0 ^f
Strawberry flavoured milk	Cow's milk	6.23±0.106 ^b	15±0.0 ^b
	Rice Milk	5.03±0.04 ^f	20±0.0 ^a
	Coconut milk	5.1±0.028 ^{ef}	8±0.0 ^f
	Almond milk	5.75±0.021 ^c	7±0.0 ^g
strawberry fermented milk	100%Rice milk	4.0±0.042 ^e	20±0.7 ^a
	90% Rice milk+10% Coconut milk	4.1±0.021 ^{de}	18±0.7 ^c
	70% Rice milk +30% Coconut milk	4.7±0.021 ^a	16±0.7 ^c
	50% Rice milk +50% Coconut milk	4.73±0.024 ^a	15±0.0 ^f
chocolate pudding	Cow's milk	7.04±0.034 ^e	5890±0.0 ^a
	Rice Milk	7.66±0.061 ^c	5870±0.0 ^c
	Coconut milk	6.63±0.067 ^g	5860±0.0 ^d
	Almond milk	8.04±0.065 ^a	5880±0.0 ^b
Cheddar cheese	100%Rice milk	7.53±0.028 ^b	1590±7.07 ^a
	90% Rice milk+10% Coconut milk	7.51±0.014 ^b	1490±21.21 ^b
	70% Rice milk +30% Coconut milk	7.15±0.014 ^d	1450±21.21 ^c
	50% Rice milk +50% Coconut milk	6.81±0.014 ^f	1430±21.21 ^d

Data are means ± standard deviations of three replicates

Table 8: Sensorial attributes of cows and vegan milks stored at °C for different storage periods

	Samples sterilization	Colour (5 points)	Taste (5 points)	Odour (5 points)	Texture (5 points)	Overall (5 points)
Milk	Cow's milk	3.75±1.38 ^{fg}	3.56±1.23 ^{efg}	3.43±1.23 ^{gh}	3.43±1.11 ^{gh}	3.67±1.14 ^{fg}
	Rice milk	2.31±1.22 ⁿ	2.68±0.79 ^{mno}	3.75±0.84 ^{ef}	3.0±1.03 ⁱ	3.12±0.68 ^{jk}
	Coconut milk	4.18±0.65 ^{cd}	3.43±0.62 ^{ghi}	3.938±0.56 ^{cde}	3.375±0.58 ^h	3.89±0.49 ^{de}
	Almond milk	3.62±1.3 ^{ghi}	2.62±1.18 ^{no}	2.938±1.42 ^{jk}	2.938±0.776 ^{ij}	3.18±1.09 ^{jk}
Strawberry flavoured	Cow's milk	3.12±1.08 ^h	2.75±1.12 ^e	3.75±1.16 ^e	3.5±1.09 ^c	3.63±1.27 ^g
	Rice milk	4.25±0.96 ^d	3.63±0.97 ^a	4.0±1.12 ^{cd}	4.0±1.12 ^a	4.25±1.034 ^b
	Coconut milk	4.5±1.12 ^b	3.25±1.03 ^b	4.5±0.93 ^a	3.88±1.23 ^a	4.0±1.05 ^d
	Almond milk	4.62±1.12 ^a	3.63±1.33 ^a	4.5±1.26 ^a	3.75±1.074 ^b	4.38±1.083 ^a
strawberry fermented milk	100%Rice milk	3.96±1.09 ^e	3.93±1.12 ^c	4.109±1.12 ^{ef}	4.51±0.94 ^a	3.93±0.67 ^{ef}
	90% Rice milk + 10% Coconut milk	3.95±0.92 ^e	4.45±1.02 ^a	4.28±1.12 ^{cd}	4.413±0.87 ^{ab}	4.2±1.21 ^c
	70% Rice milk + 30% Coconut milk	4.53±1.36 ^b	4.53±1.02 ^a	4.459±1.06 ^b	4.3±0.99 ^{bc}	4.53±0.92 ^b
	50%Rice milk +50% Coconut milk	4.8±0.96 ^a	4.63±0.91 ^a	4.63±0.81 ^a	3.98±0.84 ^f	4.78±1.12 ^a
chocolate pudding	Cow's milk	5.0±1.09 ^a	4.83±0.93 ^a	4.83±0.88 ^a	4.5±0.89 ^b	19.40±1.16 ^a
	Rice milk	3.67±1.34 ^h	3.83±1.42 ^h	4.17±0.93 ^f	4.17±1.12 ^d	17.68±1.21 ^b
	Coconut milk	3.5±1.09 ⁱ	3.5±1.31 ^j	4.0±1.38 ^h	3.17±1.41 ^h	16.48±1.064 ^{cd}
	Almond milk	4.83±0.92 ^g	4.0±1.17 ^g	4.17±1.33 ^f	3.67±1.26 ^f	17.68±1.12 ^b
Cheddar cheese	100%Rice milk	3.625±1.22 ^f	4.19±1.09 ^b	4.86±1.26 ^a	4.8±1.03 ^a	17.20±1.29 ^b
	90%Rice milk + 10% almond milk	3.875±0.82 ^e	4.06±1.25 ^c	4.88±1.22 ^a	4.13±1.22 ^d	17.24±1.36 ^b
	70%Rice milk + 30% almond milk	4.375±1.24 ^a	4.69±1.19 ^a	4.81±1.27 ^a	4.69±1.09 ^b	18.56±1.06 ^a
	50%Rice milk + 50% almond milk	4.25±1.02 ^b	4.75±1.23 ^a	4.83±1.19 ^a	4.0±0.79 ^e	18.84±1.01 ^a

Data are means± standard deviations of three replicates

Means in a column not sharing the same letter are significantly ($P \leq 0.05$) different.

ference could be found in the odour of the Cheddar cheese samples prepared in the present study (Table 8).

The significantly ($P \leq 0.05$) highest scores given by panelists to texture were for each of for following: for the strawberry milk: rice milk and coconut milk. For the strawberry fermented milk it was (100% rice milk) and for the cheddar cheese 100%rice milk (Table 8).

It was obvious that each of the following products gained the significantly highest ($P \leq 0.05$) scores given for overall acceptability: Almond milk in the strawberry milk, blend of (50% rice milk +50% coconut milk) in the strawberry fermented milk. Meanwhile, blends of milk (50% rice milk +50% almond milk) and (70% rice milk + 30% al-

mond milk), were for Cheddar cheese and chocolate pudding along with the cow's milk (Table 8). Consequently, it is advisable to manufacture the aforementioned products from vegan milks to insure their high acceptability by the consumers.

Microbiological quality of products made from vegan milk

In the present study, four food products were made from two vegan milks (BRM and CM). These products were microbiologically investigated in terms of the following parameters: Total count, aerobic spore forming bacteria, coliform, moulds & yeasts, psychrophilic bacteria and probiotic growth. No microorganisms could be detected in one millileter. The only exception was strawberry

fermented milk that exhibited the following probiotic growth:

- 5×10^5 CFU/g (100%BRM) ,
- 13.7×10^5 CFU/g (90%BRM+10%CM) ,
- 19×10^5 CFU/g (70%BRM+30%CM) , and
- 36×10^5 CFU/g m (50%BRM+50%CM) .

Data are mean values of triplicate analysis. Super script letters following numbers in the same row denote significant differences ($P \leq 0.05$) attributes

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تكوين وتقييم بعض المنتجات الغذائية الجديدة المحتوية على الألبان النباتية

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تم تحضير كل من لبن اللوز، لبن الأرز، لبن جوز الهند، بالإضافة إلى تصنيع منتجات منها مقارنة بالكنترول (اللبن البقري خالي الدسم) واشتملت هذه المنتجات كلاً من اللبن بالفراولة وبودنج الشيوكولاتة ولبن فراولة متخمّر، جبن شيدر قابل للفرد.

أجرى تقييم كيميائي للألبان المحضرة، وتبين أن لبن اللوز كان الأعلى معنوياً في محتواه من البروتين (١,٦٪) على عكس لبن جوز الهند الذي حصل على النسبة الأدنى من البروتين (٣,٢٪)، وتميز لبن اللوز بمحتواه العالي معنوياً من العناصر المعدنية التالية: البوتاسيوم، الكالسيوم، الزنك، الماغنسيوم.

أوضحت نتائج التقييم الحسي تميز لبن الفراولة المصنوع من كل من لبن اللوز، لبن جوز الهند حيث حصلنا على أعلى درجات تقييم من قبل المحكمين على عكس لبن الفراولة المصنوع من اللبن البقري حيث كان الأقل تقبلاً معنوياً. وكانت أفضل الخواص الحسية للبن الرايب بالفراولة + ٥٠٪ من لبن جوز الهند المخزن لمدة يوم واحد وبوجه عام فقد كانت أفضل خواص الجبن الشيدر الحسيه معنوياً هي للعينات التي تم تصنيعها باستخدام ٧٠٪ من لبن الأرز + ٣٠٪ من لبن اللوز.

أما بالنسبة لبودنج الشيوكولاته، فكانت العينات الأكثر تقبلاً معنوياً من قبل المحكمين هي تلك المصنوعة من اللبن البقري يليها البودنج المصنوع من لبن الارز ثم لبن اللوز.