Textural Profile Characterizations of White Brined Cheese Manufactured from Sheep's, Goat's or Combination Milk Mixtures

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ABSTRACT

Background: White-brined cheese is widely consumed and produced in the Mediterranean countries and Jordan. Traditionally, white-brined cheese produced from sheep's milk. The study aimed to examine the effect of storage duration and mixing different milk proportions and combinations of sheep's and goats milk on cheese yield and texture profile of white-brined cheese.

Methods: Jordanian WBC which is made by mixing different proportions from sheep's and goat's milk types then boiled for 15 min. Some characteristics such as texture profile and cheese yields were measured and evaluated. after storage for 12 months at room temperature.

Result: WBC made from sheep's milk or from mixtures of sheep's and goat's showed an increase in cheese yield by 11.07% and 5.59% for sheep's and sheep's milk mixtures, respectively. The addition of goat's milk in a percentage >25% to sheep's milk decreases cheese hardness and gumminess while adding goat's milk in a percentage of 25% causes a significant increase in cheese hardness, cohesiveness and gumminess. The increase in hardness for treatment 5 to 4801.2±1463 gf compared with the control treatment 1 of 4111.4±1401 gf. Storage of WBC increased hardness significantly ($p<0.05$) after 12 months by 47.2% of WBC made from sheep's milk. The texture profile and cheese quality characteristics of White brined cheese are influenced by storage time and milk types.

Key words: Adhesiveness, Cohesiveness, Gumminess, Hardness, WBC.

INTRODUCTION

White-brined boiled cheese is one of the traditional cheese types produced in Middle Eastern countries, Jordan, Syria and Palestine in particular and is widely known in Middle Eastern countries. Abd El-Salam and Alichanidis (2004). Most recent white-brined cheese was produced in Turkey and Balkan countries but differed from the typical white-brined boiled cheese characteristics produced in Syria, Jordanand Palestine and was classified as semi-hard cheese. Abu-Alruz (2023), It is used as a main additive in the production of local traditional sweets known as Kunafa. To meet consumer requirements and improve the quality of these products Which are made from sheep milk, are used a mixture of .sheep's and goat's milk in the production of White-brined cheeses (Sant'Ana *et al*., 2013). where goat milk is distinguished low lactose content and high sugar content (Yadav *et al*., 2016). The quality of the milk used also affects the quality of the final products (Morand *et al*., 2007). Research shows that the milk composition is affected by the milking period at the end of lactation peaks and leads to an increase in milk constituents (fat, protein and dry matter) that affects the nutritional value of the produced cheese (Boukria *et al.,* 2020). Also, it was found that the coagulation rate and curd consistency are better in milk produced in the morning. To improve the quality of white-brined cheese, many studies have been carried out, including improving the method of producing boiled white-brined cheese. Zullo *et al*. (2005) also studied the effect of heating cans containing brine and cheese on the preservation of the product with an emphasis on halotolerant bacteria. The effect of different combinations of PH and brines on the storage ability and sensory quality of boiled white cheese was studied. Herzallah (1994). The effect of using potassium chloride instead of sodium chloride on the properties of Nabulsi cheese was studied by Mebrat *et al*. (2016) who found no significant differences between control cheeses and experimental cheeses in chemical composition or texture profil-proteolytic activities were higher in cheeses kept in brine solutions that contained higher KCL compared with the control at the end of the storage period, hardness and gumminess generally decreased significantly within the same salt treatment (Tamime *et al.,* 2011).

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The importance and objectives of the research

A few attempts have been made to systematically study the use of goat or combined goat and sheep's milk in the production of white cheese. Therefore, the objectives of the study were, to manufacture white-brined cheese by using different milk types and combinations of sheep'sand goat's milk and study sensory, properties, textural profile characterizations of white brined cheese manufactured in zero time, after storage for 12 months at room temperature.

Research hypothesis

Combining milk from different species in the production of white cheese can improve the quality characteristics of fermented dairy products and produce new ones with and textural profile characterizations.

MATERIALS AND METHODS

Experimental design

A factorial experiment Study of the effect of three factors, storage time zero time, 6,12-month, type of milk, sheep's, goats, milk, the combination of 1:1 sheep'to goats, milk. 1:3 sheep's to goats, milk, 3: 1 sheep's to goats, milk and salted vs. desalted cheese. Two replicates were used to study the effect of these factors on textural profile characterizations and yield of white-brined cheese number of samples analyzed: 80 sample.

Manufacturing white brined cheese

Fig 1 shows the steps of manufacturing white brined cheese, which was carried out at Dairy Factory Agriculture, Mutah University, according to the traditional method described in Fig 1 with some modifications related to the type of milk. The boiling method after packaging in glass containers (18% salt solution) used in this study in five combinations (Fig 1) contains a different percentage of sheep and goat milk to produce white brined cheese as follows:

Manufacturing white brined cheese, which was carried out at Dairy Factory Agriculture, Mutah University, according to the traditional method. by use raw sheep's and goat's milk provided by the Faculty of Agriculture Farm, Mutah University. The milk was tested after filtering for specific gravity.

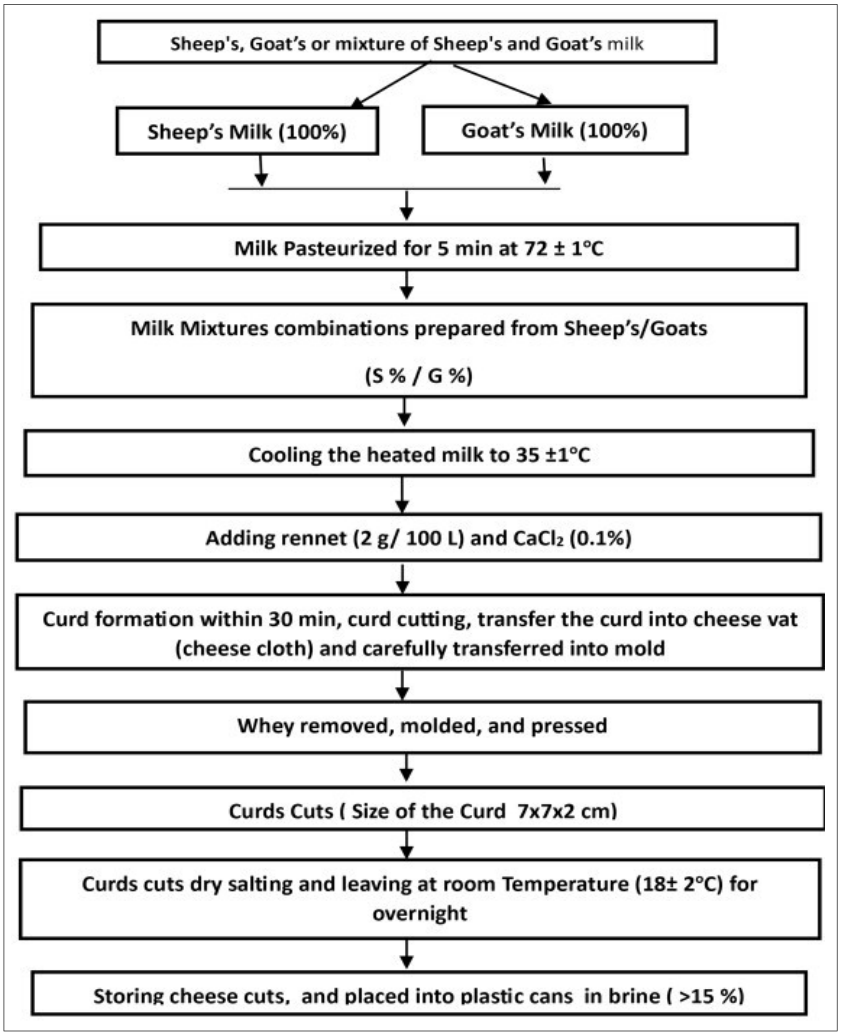


Fig 1: White cheese production process made from milk combinations.

Manufacturing white-brined cheese begins with pasteurization and cooling (50°C) of milk, followed by the addition of starter cultures or without adding starter cultures, followed by the addition of rennet enzyme (0.001%) and curd formation at 30 to 50 minutes. Then drain in molds and cut into pieces, Add dry salt to the cheese pieces, then heat them up in a brine solution (Concentration 18 to 21%) for 5 to 10 minutes, cool. This type of cheese is stored using highly concentrated salt solutions (>15%), so it must remove the salt from it or reduce its quantity by soaking it in water for 2 to 6 hours, before consumption.

Yield of white-brined cheese

Cheese yield is a very important element in cheese production which they crucial factor in determining the price per kilogram for fresh raw milk and evaluating the effectiveness of any new additions or modifications in the manufacturing process. is evaluated after pressing and calculated according to the following equation:

$$\text{Cheese yield} = \frac{\text{Weight of cheese}}{\text{Weight of milk}} \times 100$$

(BarBowska *et al*., 2011)

Texture profile analysis of white-brined cheese

Texture profile analysis (TPA) represented by hardness, cohesiveness, adhesiveness and gumminess was performed using a texture analyzer (model TVT 6700, Perten, Sweden) using a 30 kg load cell. A stainless-steel cylinder probe (45 mm in height and 50 mm in diameter) was used to compress the sample. The TA measuring conditions were briefly: a number of compression cycles, 2; starting distance from the sample, 5 mm; compression, 50%; pause between cycles,3; distance above trigger initial speed, 1 mm/s; test speed, 1 mm/s; retract speed, 1 mm/s; trigger force, 10 g and data rate, 250 pps. Cy (inder cheese samples (15 mm in height and 20 mm in diameter) were cut from cheese pieces using a round -steel cutter. Samples were tested after desalting, which was performed by overnight soaking cheese pieces in tab water at refrigeration temperature (5°C). Samples were brought to room temperature before testing and results were provided directly from the TPA software.

Statistical analysis

The obtained data was reduced using SPSS (Ver 22). One-way ANOVA was used to analyze experiments with one, factor. Means separation was performed using the least significant difference test (LSD). A two-way ANOVA was used for experiments with two factors.

Results and Discussion

Yield of white brined cheese production from different types of milk after pressing and salting

The apparent yield of white brined cheese was calculated as the cheese weight after pressing for 30 min and salting at room temperature then storage in a brine solution 18% for 24 h divided the weight of the milk used. also, the amount of fresh raw milk required to produce 1 kg of cheese or cheese amount obtained from 1 kg of fresh milk, is called cheese yield. Haenlein (2007) is affected by many factors, including milk content of fat, proteins, moisture, storage temperature, milk quality, milk heating (pasteurization)and manufacturing standards Also, the cheese yield estimated from sheep's and goat's milk was between 26% and 28% and 15%-16% respectively (Park *et al*., 2007).

The results of the experiment indicate the amount of cheese yield obtained from five different combinations of sheep's and goat's milk presented in Table 1 noting that the highest cheese yield was for treatment 1 at 26.23% and 5 at 24.98%. and this could be attributed to the increase in the percentage of sheep milk used, which contains 5.4%, 6.79% and 16 .87% fat, protein and total dry matter, respectively. Also attributed to The capacity of sheep's milk to retain all milk nutrients in the curd. Garcia *et al.* (2014). Also, results showed that cheese yield produced from sheep's milk was 11.07% higher than cheese yield produced from goat's milk after pressing (AP), and this percentage drops down when On the contrary, another researcher published that there were no significant differences in cheese yield according to levels of somatic Cell count in milk. (Hen *et al.,* 2010; Mazal *et al.,* 2007). While results published by Barbano *et al.* (1991) showed an increased somatic cell count, It is observed that significantly lower cheese yields. A protein affects cheese texture and stability

Table 1: Cheese yield produced using different milk types 1.

Treatment 2	Milk type		Cheese yield		
	Sheep's (%)	Goat's (%)	AP3 (%)	AS4 (%)	Change5 (%)
1	100	None	26.23±0.25a	23.05±0.42a	3.18
2	None	100	15.16±0.49d	13.43±0.42d	1.73
3	50	50	21.58±0.49b	18.63±1.17b	2.95
4	25	75	19.39±0.09c	16.36±0.36c	3.03
5	75	25	24.98±0.80a	21.87±0.19a	3.11

1: Values within that same column of the yields having same superscript are not significantly different (P>0.5), 2: Milk types (Sheep's, Goat's, Mixture), 3: Cheese yield after pressing, 4: Cheese yield after salting, 5: Cheese yield changes before and after salting.

is exacerbated by drying the cheese body and salt will also drain more whey (moisture) out of the cheese. This led to decreases in cheese yield (Gunee, 2004).

Also, the results show in Table 2 that white-brained cheese made from sheep's milk only (SMC (had a higher value of protein and fat than cheese made from goat's milk (GMC) alone. Also, the results show that mixing 75% GM with 25% SM showed a decrease in protein, fat and dry matter contents compared with cheese made from 100% sheep's milk. Results also showed that the highest value of dry matter was for treatment (Table 2) of the cheese produced from SM (100%) of 60.521.5, while the dry matter was the lowest for treatment (56.39±1.9). The ash content of the cheese produced from different milk combinations was between 10.68 and 12.28%. The results found that both milk compositions influence the final, white-brained cheese composition, which agrees with (Vyhmeister *et al*., 2019).

Table 2: Effect of using different types of milk on chemical composition of white-brained chee.

Treatments			White-brained cheese					Brine		
Treatment	Milk type		Dry matter (%)	Moisture (%)	Protein white-brined cheese	Fat (%)	Ash (%)	Salt (%)	pH	Salt (%)	pH
	Sheep's (%)	Goat's (%)									
1	100	-	60.52±1.15a	39.48±1.15a	22.99±0.1a	23.75±0.35a	10.68±0.13a	9.92±0.4a	6.64±0.27a	19.69±0.8a	6.73±0.19a
2	-	100	56.39±1.29a	43.61±1.29a	20.42±0.17a	20.50±1.41a	10.60±0.52a	10.33±0.66 a	6.86±0.03a	19.85±0.95a	6.92±0.05a
3	50	50	57.49±3.03a	42.51±3.04a	21.80±2.44a	21.25±1.77a	10.87±0.16a	10.38±0.71a	6.60±0.25a	19.94±1.17a	6.76±0.11a
4	25	75	57.37±0.08a	42.63±0.08a	20.84±0.98a	20.75±0.35a	11.33±0.04a	10.28±0.2a	6.81±0.11a	20.16±0.47a	6.74±0.16a
5	75	25	58.44±1.17a	41.56±1.17a	22.22±0.23a	21.25±1.1a	12.28±0.55a	10.35±0.81a	6.89±0.2a	20.67±0.1a	6.63±0.15a

Texture profile of white brined cheeses manufactured from different types of milk

White brined cheese hardness

The effects of milk types on the texture profile of the white-brined cheese produced from different milk combinations were evaluated and presented in Table 3. As noted, the milk types have an effect on the texture profile of the white brined cheese compared to Treatment 1 (100% Sheep's milk) and Treatment 2 (100% Goat's milk). This result showed that mixing sheep's milk with 50% or 75% Goat's milk led to a significant decrease in cheese hardness for samples from treatments 3 and 4 as compared to treatment 1 (100% sheep's milk) of values 3566.9 and 3225.7 respectively, compared with the control treatment1 that was 4111.4 g. This may be attributed to the size of the fat globules in goat milk. Goat's milk had more short and medium chain fatty acids (MCT) than cow's milk, as well as higher goat's milk alkalinity and buffering capacity, but adding goat's milk in a percentage not more than 25% as at Treatment 5 resulted in a significant increase in cheese hardness to 4801.2. The hardness of cheese might be linked to composition particularly fat, protein, or dry matter, which play a role in the hardness of cheese, white brined cheese produced from goat's milk It has a higher hardness value than cheese produced from sheep's milkand this is due to the low amount of fatand protein quality that a high-fat content contributes to smoothness in cheese. Whereas high protein content increases the hardness of the cheese, a high level of total solids content and high acidity also make cheeses harder (Koca and Metin, 2004).

Cohesiveness

A measure cheese, when subjected to compression, is defined as the extent of resistance and strength of the internal structure that forms the body of the product to deformation when subjected to compression, calculated as the area of the second compression curve (second bite) divided by the area the first bite compression curve (second compression/first compression area). The highest

cohesiveness value for treatment 2 (100% goats' milk) of a value -0.71 compared with the least cohesiveness value for treatment1 (100% sheep's milk) as the control treatment of 0.67 and there was a significant difference ($p<0.05$) between Goats and Sheep's cheeses. On the other hand, cheese samples of other samples were very close and there were no significant differences between them. This means that the difference in the type of milk and the proportions used do not affect the cohesiveness of the cheese (Karaman and Akalin, 2013). This was also observed in the study conducted, which found a negative correlation between fat content, dry matterand cohesiveness. On the contrary, a positive correlation was found between the dry matter content and cohesiveness, as found by Bryant *et al*. (1995); Delgado *et al*. (2011).

Adhesiveness is expressed as measurements of force required to overcome the attractive forces of food on the mouth surface, which in sensory terms is the degree to which the food adheres or sticks to teeth within the mouth surface. These results show that adhesiveness values were very low for all treatments, but the results of adhesiveness. The variations in adhesiveness values might result from differences in their chemical composition. Table 3 show a significant difference between treatments1 produced from 100% sheep's milk had the highest adhesiveness value of -3.84 and the lowest adhesiveness of -9.82 J for treatment 5. The negative sign of adhesiveness values is stress directed down. The variations in adhesiveness values might result from differences in their chemical composition. White-brined cheese, adhesiveness has been negatively correlated with protein content and positively correlated with FDM and SM levels (Goksel *et al*., 2013).

Fat is presented as globules contained within the protein matrix network in cheese curd allowing cheeses to melt better and thus increase adhesiveness. McSweeney (2004). Also, the results show that increasing potassium salts increases adhesiveness. Ousman *et al.* (2008) too and this may be related to the observed increases in fat globule size and pH value (Bakry *et al.*, 2011).

Gumminess

The energy required to disintegrate a semi-solid food until it can be swallowed is a value calculated from hardness times the cohesiveness. Therefore, factors such as the hardness and cohesiveness of the sample also affect the gumminess. The evaluated gumminess value for the produced white brine cheese produced from different milk combination results are shown in Table 3, a significant effect ($p<0.05$) when adding goat's milk in a percentage of greater than 25% to sheep's milk gives the highest gumminess value for sample from treatment 5 of 3242.9 g and the lowest value for samples from treatment 4 of 1897.5 g (Table 4). It was also observed that there was a significant difference between the Gumminess of white brined cheese produced from 100% goat's milk, which reached 2201.4 g, while the cheese produced from 100% sheep's milk, of 2815.1 g.

The textural profile of white brined cheese (Nabulsi cheese) through storage time

Table 4 summarizes the effect of storage time on texture profiles for treatments 1, 2 and 3. were it is observed that changes in all textural properties of cheeses during storage in brine solution significantly affect ($p<0.05$) hardness, gumminess and cohesiveness values of the cheesesand these parameters decreased significantly ($p<0.05$) at the end of 6 and 12 months of storage as a consequence of proteolysis, which causes the release of ionic groups of water-binding, redistribution of saltand a decrease in water activity (aw), as well as low pH and breakdown of casein micelles into small aggregates (Jooyandeh, 2009).

The results presented in Table 4 using treatment number one as a control (white brined cheese made from sheep's milk) show that adding goat's 'milk in a percentage of 25% resulted in an increase in hardness, cohesiveness and gumminess (significant $p>0.05$) and a reduction in adhesiveness.

The values of the parameters were 5190.33 g, 0.700, 3491.23 g and -12.53 J for hardness, cohesiveness, gumminess and adhesiveness, respectively. In addition, the hardness and gumminess of all samples continuously decreased after six months of storage at different rates, The decreases in hardness values, may be due to the hydrolysis of casein, which is responsible for softening the cheese. Treatment 4 had the least hardness and gumminess, but after 12 months of storage, an increase

Table 3: Texture profile white brined cheese (Nabulsi cheese) produced of different proportions of sheep and goat milk.

Treatments			Texture profile analysis 1, 2			
Treatment number	Types of milk used in processing		Hardness (g)	Cohesiveness	Gumminess (g)	Adhesiveness (J)
	Sheep's milk (%)	Goat's milk (%)				
1	100	-	4111.4±1401.58b	0.67±0.10b	2815.1±803.86b	-3.84±2.79a
2	-	100	3287.8±1298.51c	0.71±0.09a	2201.4±733.06c	-6.52±1.24b
3	50	50	3566.9±1409.72c	0.68±0.08ab	2362.5±825.80c	-6.32±2.25b
4	25	75	3225.7±1185.99c	0.69±0.07ab	1897.5±629.03d	-8.82±2.85c
5	75	25	4801.2±1463.87a	0.69±0.07ab	3242.9±834.19a	-9.82±3.27c

1: Values are the averages of triplicates presented as means±SD. 2: Values within column with the same letter not significantly different (P>0.05).

Table 4: Texture orofile white brined cheese (Nabulsi cheese) produced of different proportions of sheep and goat milk through storage.

Treatments				Texture profile analysis 1, 2			
Treatment	Storage time (month)	Sheep's milk(%)	Cow's milk (%)	Hardness (g)	Cohesiveness	Gumminess (g)	Adhesiveness (J)
1	0	100	-	4237.00±359.79bc	0.67±0.06a	3145.73±377.43ab	-6.77±2.47cd
2		-	100	3272.00±169.64d	0.73±0.05a	2448.10±93.00c	-5.40±0.20d
3		50	50	4816.33±138.07b	0.67±0.06a	3340.70±64.10ab	-8.87±1.64c
4		25	75	3596.33±464.3cd	0.70±0.01a	2248.27±79.36c	-11.83±0.58ab
5		75	25	5190.33±300.24a	0.70±0.01a	3491.23±362.6a	-12.53±0.95a
1	6	100	-	2470.33±407.67ab	0.76±0.06a	1830.20±346.69ab	-3.77±0.15c
2		-	100	1833.33±506.30bc	0.80±0.01a	1269.63±198.63cd	-6.73±0.50b
3		50	50	1847.67±456.40bc	0.77±0.01a	1480.60±203.42bc	-4.13±0.25c
4		25	75	1777.67±414.32c	0.77±0.05a	1064.07±11.42d	-7.83±1.01b
5		75	25	2975.67±182.21a	0.77±0.06a	2251.07±126.40a	-10.80±2.25a
1	12	100	-	5627±230.53b	0.57±0.06a	3471.60±237.89b	-1.00±0.20b
2		-	100	4758±208.62c	0.60±0.01a	2886.53±61.17c	-7.43±1.62a
3		50	50	4036.67±784.62d	0.60±0.01a	2266.07±257.36d	-5.97±0.6a
4		25	75	4303±383.31cd	0.60±0.01a	2344.07±115.97d	-6.80±3.15a
5		75	25	6237.67±356.57a	0.60±0.01a	3986.50±488.36a	-6.13±1.95a

1: Arithmetic means ±.SD, 2: Storage time of means in each column with the same letter are not significantly different (P>0.05).

in the hardness and gumminess values for all samples was noticed. On the contrary, treatment 5 showed more hardness and gumminess of 6237.67 g and 3986.50 g, respectively. Results presented in Table 4 also indicate that cheese cohesiveness for all treatments is close to those values after manufacturing of 0.700. Whereas, after 6 months of storage in brine solution, it increased to 0.77 for milk combinations of 75 sheep's milk and 25% goat's milk. The results also indicate that no significant difference between the different treatments during the same storage period. On the contrary, the cohesiveness values insignificantly decreased to 0.60 (p>0.05) during storage at room temperature for 12 months. On the contrary, the adhesiveness of -12.53 J after the manufacturing of white brined cheese from sheep's milk of 75% and goat's milk of 25%, increases to -6.13 J after storage time of 12 months. This could be attributed to the fat, protein contentand proteolysis during storage (Dimitreli and Thomareis, 2007).

Recommendation

We recommend adding goat's milk in certain proportions to sheep's milk to produce white-brined cheese because goat's milk contains functional compounds such as prebiotics and a low amount of lactose. compare with other milks. Although white-brined cheeses produced from sheep's milk have a higher nutritional value than cheese produced from goat's milk.

Conclusion

The results showed possibility of using different proportions of goat's milk in cheese-making with good properties. These results mean that the texture profile and cheese quality characteristics of white brined cheese are influenced by storage time and milk type.

White-brined cheese characteristics can be improved by using proportions and different types from sheep's and goat's milk WBC made from sheep's milk or mixtures of sheep's and goat's an increase in cheese yield by 11.07% and 5.59% for sheep's and sheep's milk mixtures, respectively. The addition of goat's milk in a percentage > 25% to sheep's milk decreases cheese hardness and gumminess while adding goat's milk in a percentage of 25% causes a significant increase in cheese hardness, cohesiveness and gumminess.

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Conflict of Interest

The author(s) declares no conflict of interest.

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