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VALUE ADDITION TO FROZEN DESSERTS THROUGH INCORPORATION OF PUMPKIN SOLIDS AND UF MILK PERMEATE

[62]

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ABSTRACT

Sherbet and Sorbet mixes were prepared to contain 9% fresh mango pulp, *per se,* 1% cooked pumpkin (CP). The water quantity required for both was replaced with ultrafiltrated milk permeate (UFMP) at the level of 25, 50 or 75%. The obtained results indicated that, separately, CP composed of higher moisture and total nitrogen, total phenolics (TP) as well as radical scavenging activity (RSA) values and lower total flavonoids (TF), carbohydrates contents than mango pulp. In both, Sherbet and Sorbet mixes, water substitution with UFMP was associated with increase in total solids, total and reducing sugars as well as ash contents. Neither acidity %, nor pH values were significantly affected by the partial substitution of water with UFMP in Sherbet mix, although the acidity % of Sorbet mix was significantly increased by UFMP addition. Freezing point of Sherbet or Sorbet mixes was gradually minimized by increasing the substitution level, although the flow behavior index was not influenced in Sherbet but increased in Sorbet mixes. The proportional increment of UFMP level in mix was associated with gradually considerable increase in its consistency coefficient, apparent as well as dynamic viscosities, TP and RSA values of both Sorbet and Sherbet mixes. UFMP led to increase in the specific gravity of mixes before and after freezing as well as elevated the overrun and strengthened the melting resistance of the final product. Furthermore, the frozen dessert of 75% UFMP, whether being Sherbet or Sorbet gained the highest panelists scores for all sensory attributes. It could be concluded that, it could successfully produce a product that meets the intended health purposes based on the substitution of 10% of mango pulp with pumpkin solids of many impressive health benefits as well as the utilization of ultrafiltration milk permeate as a source of the essential electrolytes instead of 75% of required water *en* route to innovate frozen desserts such as Sherbet and Sorbet.

Keywords: Frozen desserts; Sherbet; Sorbet; Antioxidant activity; Physiochemical and Rheological properties

INTRODUCTION

Ultrafiltration (UF) of milk produces a large quantity of permeate as by-product. The dairy industry generates significant liquid waste; whose disposal requires a large amount of capital investment. The permeate contains Lactose as the major constituent in addition to water soluble vitamins and the soluble salts of milk (**Dragana et al 2013**). Therefore, UF-milk permeate (UFMP) can be considered a nutritive food ingredient. UFMP poses a problem for dairy industries in its disposal as a source of environmental pollution, because of its associated high biological oxygen demand **(Fayed, 1986)**. UFMP is comprised primarily of lactose (5%), water (93%), and considered as a source of high quality vitamins and minerals which are important for human health. UFMP contains electrolytes such as sodium, potassium, magnesium, zinc and calcium. Great attentions were directed for utilizing UFMP in the production of many useful products, such as for sports drinks **(Hattem et al 2010)**.

Mango fruit contains several bioactive principles, viz. polyphenols, flavonoids, carotenoids and ascorbic acid having different beneficial properties because of their antioxidant activities **(Muralidhara et al 2019).** On the other hand, pumpkin refers to

Cucurbita pepo, an orange type of winter squash. While commonly viewed as a vegetable, pumpkin is scientifically a fruit, as it contains seeds. Beyond its delicious taste, pumpkin is nutritious and linked to several health benefits **(Gong et al 2012)**. Where, pumpkin is high in vitamins and minerals, at the same time low in calories. Pumpkin is also a great source of antioxidants, α-carotene and β-carotene, a carotenoid that gets converted in the body into vitamin A, along with lutein and zeaxanthin. These are beneficial in protecting eyes against sight loss and can help keep the skin strong and healthy; i.e. acts as a natural sunblock (**Pullar et al 2017).** Pumpkin contains β-kryptoxanthin which may protect cells against damage by free radicals (**Khansari et al 2009).** These compounds are linked to lower risks of stomach, throat, pancreas and breast cancers (**Zhou et al 2016)**. It is also a good source of vitamin C that can help boost the immune system. Its supply of vitamin E, iron and folate may strengthen the immunity (**Veldhoen and Ferreira, 2015).** Pumpkin also supplies dietary fiber which have impact on gut health (**Vinceti et al 2016**).

Out of the total frozen desserts produced in 2000 in the United States, about 1.5 billion gallons, Sherbets and ices comprised about 3.6 and 4.3%, respectively. Sherbets made up about 1 % of the soft-serve products. Also in 2000 in Canada, where total annual production of frozen desserts is about 323 million liters, Sherbets and water ices comprise about 3.4 and 4.8%, respectively. These products are in great demand in the summer months **(Marshall et al 2003)**.

A Sherbet is frozen foam made from water, nutritive sweeteners, fruit or fruit flavoring, fruit acid, milk solids, stabilizer, and coloring. Sherbets contain 1-2% milk fat (no other fat permitted) and at least 1% non-fat milk solids (NFMS) with the total milk solids between 2 and 5% (**Code of Federal Regulations "CFR", 2018)**. Standards in other countries may vary; e.g., in Canada maximum of 5% milk solids, including milkfat is permitted. This acidic food, when characterized by a fruit flavor, has a minimal titratable acidity of 0.35% calculated as lactic acid **(Marshall et al 2003)**.

Ices or water ices, sometimes called Italian ices, have essentially the composition similar to that of Sherbets, except that they do not contain any milk solids and egg ingredient, except for egg white. They are frozen and simultaneously whipped to contain overrun ranging from 0 (quiescently frozen bars) to 30% (dynamically frozen items). Sorbets are an upscale version of ices in that they contain fruit, fruit juices and/or fruit extracts rather than imitation flavorings. Sherbets and water ices are defined foods (**Code of Federal Regulations "CFR", 2018)**, but Sorbets are not a defined food in the United States.

The objective of this study was to fruitfully utilize a rich source of the essential electrolytes, namely UFMP as well as impressive health benefits of pumpkin in producing Sherbet and Sorbet (true fruit flavored water ice) using fresh mango pulp *en* route to innovate functional products.

MATERIALS AND METHODS

Materials

Skimmed milk powder (3.8 % moisture, 34% protein, 1.5% fat and 8.3% ash).was obtained from Synlait Milk Ltd., Rakaia 7783 - New Zealand. Ultra-filtered milk permeate (UFMP) was obtained from Animal Production Research Institute, Agricultural Research Center, Giza, Egypt. Mango fruit (*Mangifira indica*), variety Zebdia, were purchased from El-Obour market, El-Obour City, Qalyoubia governorate, Egypt. Fresh pumpkin fruit (*Cucurbita pepo*) were obtained from local market, El–Sheikh Zayed city, Giza governorate, Egypt. Commercial grade granulated cane sugar produced by Sugar and Integrated Industries Co. at Hawamdia, Giza governorate, Egypt. Sodium carboxy methylcellulose (CMC); made by BDH chemicals Ltd poole; England, was obtained from the local market. Citric acid was obtained from El-Gomhouria Co. for Drugs and Medical Supplies, Cairo, Egypt.

Experimental procedures

Preparation of mango pulp

Mango fruit (*Mangifira indica*) were washed and then peeled. Seeds were removed to get the mango pulp, which was blended to obtain a homogenous product. Pulp yield reached 60 -65% of fruit weight.

Preparation of cooked pumpkin cubes

Pumpkin (*Cucurbita pepo*) fruit (*ca* 4 kg) was washed and cut into 2 halves; the seeds were removed. The peeled pumpkin fruit was portioned into small cubes of equal size (*ca* one cm^3) and cooked in hot water at 90°C for 5 min. Thereafter, cooked pumpkin cubes were cooled to *ca* 4° C.

Preparation of mango Sherbet replaced with 10% (cooked pumpkin and mango pulp) made using milk permeate instead of water with different levels

The manufacturing procedure was carried out as described by **Marshall et al (2003)** and provided by **EOSQ (2005a).** Sherbet base mix (the control) was prepared to contain 5% milk solids not fat, 9% mango pulp, 1% cooked pumpkin, 25% sucrose, 0.2% CMC and 59.5% potable water **(Table, 1)**. The water portion of mix was replaced with UFMP at levels of 25, 50 or 75% and mixed well. All the mixes were blended for 5 min, heat treated at 85°C for 5 min. and then cooled to 5°±1°C and aged at this temperature for 48 h. Thereafter, each aged mix was frozen in an experimental ice cream batch freezer at -18°C. The ice cream freezer (Taylor, Model, 103) is automatically controlled to stop whipping after 18-20 minutes, when ice cream was frozen.

Table 1. Recipe of mango Sherbet replaced with 10 % cooked pumpkin (CP) made using ultrafiltered milk permeate (UFMP) in place of water at varying levels

Ingredient (g)	Water replacement level with UFMP			
	Nil (control)	25%	50%	75%
Skim milk powder	53.00	53.00	53.00	53.00
Mango pulp	90.00	90.00	90.00	90.00
CP	10.00	10.00	10.00	10.00
Sucrose	250.00	250.00	250.00	250.00
CMC	2.00	2.00	2.00	2.00
UFMP	0.00	148.725	297.450	446.175
Water	595.000	446.275	297.550	148.825
Total	1000	1000	1000	1000

The air pressure in compressor unit was adjusted to be in the range of 3-4 bar absolute pressure. The frozen product was drawn from the freezer in the soft form at approximately - 7°C. The resultant product was filled into PVC cups (cap. 100 ml) covered with lid and hardened in a deep freezer at -20°C for 24 h prior to analyses. Three replicates were done for every treatment.

Preparation of mango Sorbet (true fruit flavored water ice) replaced with 10% cooked pumpkin containing UFMP to replace water portion of mix at varying levels

The manufacturing of Sorbet (fruit flavored water ice) was carried out as detailed by **Marshall et al (2003)** and **EOSQ (2005b).** Sorbet base mix (control) was prepared to contain 9% mango pulp, 1% cooked pumpkin cubes, 30% sucrose, 0.2% CMC, 0.01% citric acid and 59.79% potable water **(Table, 2)**. The water portion of mix was replaced with UFMP at the same levels, as previously done for Sherbet mixes (i.e. 25, 50 and 75%). All the mixes were processed as mentioned under Experimental procedures; three replicates were carried out.

Table 2. Recipe of mango Sorbet replaced with 10% cooked pumpkin (CP) made using ultrafiltered milk permeate (UFMP) instead of water with different levels

Ingredient (g)	Water replacement level with UFMP			
	Nil (control)	25%	50%	75%
Mango pulp	90.00	90.00	90.00	90.00
CP	10.00	10.00	10.00	10.00
Sucrose	300.00	300.00	300.00	300.00
CMC	2.00	2.00	2.00	2.00
Citric acid	0.10	0.10	0.10	0.10
UFMP	-	149.475	298.95	448.425
Water	597.90	448.425	298.95	149.475
Total	1000	1000	1000	1000

Analytical methods

Total solids, fat, total nitrogen, fiber and ash contents of Sherbet and Sorbet mixes were determined according to **AOAC (2012).** Titratable acidity (TA) % was determined as citric acid according to **AOAC (2012).** The total sugars content was determined according to phenol-sulphuric acid method as described by **Charles (2010).** Reducing sugars content was determined according to **AOAC (2012).** Electron-donating ability was determined by implying 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging assay as described by **Brand-Williams et al (1995)**. The total phenolic content was calorimetrically determined, using the Folin-Ciocalteu method, as described by **Singleton et al (1999)**. The total flavonoid contents were determined according to the method of **Mohdaly et al (2012)**.

The pH value of the sorbet and sherbet mixes was measured electrometrically using Lab. pH meter with a glass electrode, Hanna model 8417 digital pH meter at 20°C after calibrating with fresh pH 4.0 and 7.0 standard buffers according to the methods of **BSI (1990).** The specific gravity of the mix and the final frozen product was determined according to **Sommer (1951).** Freezing point of mix was measured in accordance with **FAO (1977)** using a Digital Probe Thermometer (-40 to +200ºC) with probe 125 mm (according to HACCP), TFA Dostmann, GmbH & Co. KG, Wertheim, Germany. The overrun per cent was calculated as mentioned per **Goff and Hartel (2013)** from the figures obtained for the specific gravity (Sp. gr.) of the mix and that of the resultant frozen product using the following equation:

$$\boldsymbol{Overrun}\,\% = \frac{Sp.gr.of\ mix - Sp.gr.of\ frozen\ product}{Sp.gr.of\ \ frozen\ product} x100$$

The melting resistance of the hardened frozen product was determined as described by **Muse and Hartel (2004)**.

Measurement of rheological properties

Rheological properties of Sherbet and Sorbet mixes were measured at 10±1°C using a rotary coaxial Rheometer (RHEOTEST, type 2, Medingn, German) (**Toledo 2007).** The liquid samples were loaded in the outer cylinder (S) and then subjected to rotational shearing using the cylindrical spindles (S1) and (S2) of the Rheometer. The samples were sheared between shear rate of 0.33 to1342 s^{-1} or of 3 to 427 s^{-1} according to the type and consistency of the tested solutions. The rotation speeds and torque values of the Rheometer were converted to shear rate and shear stress (dynes / cm ^{2}) according to the operating manual of the Rheometer. All parameters were calculated from the descending flow curve to express the data corresponding the well stirred product. Consistency coefficient was calculated using the following equation:

$$Log\delta = log\ \kappa + n\ log\ \gamma$$

Where:

δ = Shearing stress, γ = shearing gradient or shear rate, n = Flow behavior index and κ = consistency coefficient or consistency index

Whilst, the yield value or yield stress was calculated by fitting the shear stress-shear rate data to the Casson equation **(Bourne, 1982):**

$$\sqrt{\delta =} \sqrt{\delta o} + \eta a \sqrt{\gamma}$$

Where:

δ = Shearing stress, δo = yield stress,
η_a = apparent viscosity and γ = shear rate

The dynamic viscosity of mixes was measured as described by **Toledo (2007)**, at shear rate 437 s^{-1}. The Sherbet and Sorbet mixes were tempered to 10±1°C before loading them in the viscometer device.

Scoring of frozen desserts was carried out by the staff members of Food Sci. Dept., Fac. of Agric., Ain Shams Univ. according to **Rothwell (1960)**. The maximum score were 40 points for consistency, 50 points for flavor and 10 points for melting quality.

The data obtained were subjected to statistical analysis according to statistical analyses system user's guide **(SAS, 2006)** using General Linear Model (GLM) with main effect of treatments. Duncan's multiple range was used to differentiate the treated samples among of three replicates at $P \leq 0.05$.

RESULTS AND DISCUSSION

Physicochemical properties of the main ingredients used in of Sherbet or Sorbet mix

As could be observed in **Table 3** cooked pumpkin was distinguished from mango for its higher value of total phenolics as well as DPPH radical scavenging activity and lower total flavonoids. **Lotfy et al (2017)** reported that, pumpkin seems to be promising as antioxidants containing food. These results of cooked pumpkin are in coincidence with those found by **Rizk (2016).** Mango attributes were as in **Muralidhara et al (2019).** The UFMP properties agree with those found by **Fayed (1986)** and **Aamer et al (2017).** While, those of skimmed milk powder are in accordance to **Fayed (1986).**

Table 3. Chemical properties of main ingredients used for making Sherbet and Sorbet mixes

Property	Ingredient			
	Mango pulp	Cooked pumpkin	Milk permeate	Skim milk powder
Moisture%	83.42[c]	91.39[b]	94.32[a]	4.20[d]
Total nitrogen%	0.128[c]	0.318[b]	0.021[d]	5.56[a]
Fat%	0.36	0.78	0.00	1.00
Ash%	0.33[b]	0.31[b]	0.15[c]	8.50[a]
Fiber%	1.50	1.35	0.00	0.00
Carbohydrates*%	13.59[b]	4.26[c]	5.40[c]	51.00[a]
Total phenolics (mgGAE/g)	33.00[b]	530.32[a]	5.55[d]	22.91[c]
Total flavonoids (mg QE /g)	264.00[a]	17.24[b]	0.49[d]	8.30[c]
DPPH radical scavenging activity %	18.66[c]	61.69[b]	18.50[c]	97.63[a]

* Calculated by difference GAE: Gallic acid equivalent QE: Quercetin Equivalent

DPPH: 2, 2-diphenyl-1-picrylhydrazyl

The means with the same letter at any position did not significantly differ (P>0.05).

Physicochemical characteristics of Sherbet or Sorbet mixes

The results of **Table 4** reveal that, an increase in the replacement of water portion of mixes with UFMP, lead to significantly (P<0.05) higher total solids (TS) in the resultant Sherbet or Sorbet mixes. A replacement level of 75% with UFMP elevated the TS level to 1.15 fold for Sherbet and 1.10 fold for Sorbet. At replacement level of 25% and 50% UFMP, the increases in TS level were 1.06 and 1.09 fold for both the products. The Sherbet mix composition agrees with that approved by **EOSQ (2005a),** while that of Sorbet mix agrees with that approved by **EOSQ (2005b).** There was hardly any variation in the TS between Sherbet and Sorbet mixes, since the relatively lower sugar content in sherbet mix (25.0%) *versus* Sorbet was compensated by 5% milk powder added in the recipe of their mixes. **(Tables, 2 and 3).**

Similar trend was noted when total sugar content was taken into consideration. When dealing with reducing sugar content of Sherbet mixes, there was an increase (P<0.05) in such component by 1.24, 1.49 and 1.74 fold (*versus* control) when the level of water replaced with UFMP were 25, 50 and 75% respectively. Similar trend was noticed when total as well as reducing sugar content of Sorbet was taken into account. In case of Sorbet mixes, the increase (P<0.05) in the reducing sugar content were 1.94, 2.94 and 3.93 fold at water replacement ratio with UFMP of 25, 50 and 75% respectively. It is worthy to mention that, at any specific water substitution level with UFMP, the Sherbet had lower total sugar (P<0.05) but higher reducing sugar content (P<0.05) (*versus* Sorbet) at the respective substitution level **(Table, 4)**.

Ash content was increased linearly with increasing level of UFMP used to replace water portion of Sherbet or Sorbet mixes. This effect was marked from 50% level of replacement. The ash content of Sherbets was significantly (P<0.05) raised by 0.07 and 0.14% at replacement level of water with UFMP at 50% and 75%, respectively. The increasing level of ash in Sorbet comply with the substitution level of water portion of mix with UFMP and it reached 1.29, 1.80 and 3.00 fold *versus* control product at replacement level being 25, 50 and 75%, respectively **(Table, 4)**.

Neither acidity nor the pH value was significantly (P>0.05) affected by substitution of water with UFMP in case of Sherbet mixes. The acidity was around 0.3% citric acid, while pH value was around 5.0. In case of Sorbet, the acidity was significantly (P<0.05) higher in product having greater level of water replaced by UFMP in the mixes. The pH value was not markedly affected by such replacement of water portion of mixes with UFMP **(Table, 4)**.

A gradual increase (P<0.05) in the specific gravity of mixes was noted with an increasing level of water replacement with UFMP in the case of both Sherbet and Sorbet mixes. The Sorbet mix had invariably lower (P<0.05) specific gravity values, noted at specified replacement level of water with UFMP, when compared with that of Sherbet mix.

The data depicted in **Table 4** revealed that freezing point of mixes recorded -3.4 and -3.1°C for control samples of sherbet and sorbet mixes, respectively. The difference in freezing point between the two tested products could be referred to their content in reducing sugar. The higher the reducing sugar content, the lower will be the freezing point, since the depression in freezing point depends more on the component of lower molecular weight (reducing sugars and salts) rather than those of higher molecular weight (Disaccharides). The freezing point got depressed with increasing substitution level of water portion of mixes with UFMP. was; the F.P. was -4.7°C for Sherbet or -4.5°C for Sorbet mixes at 75% level of replacement. That reflects the load of true soluble sugars (sucrose and fruit sugar and additionally permeate lactose in case of Sorbet, besides the further SMP lactose in the case of Sherbets) and salts in the medium. This phenomenon is, indeed, logically with regard to the proportional increment in both reducing sugar as well as ash content of Sherbet and Sorbet mixes with increasing substitution level of water portion of mixes with UFMP **(Table, 3)**.

The curves illustrated in **(Fig. 1)**. Demonstrate the extent of the correlation in the ascending relationship between the level of replacement of water with UFMP, whether of Sherbets or Sorbets, and the level of the total dissolved components and their inverse relationship with the freezing point of the mix. With increasing proportion of water substitution with UFMP in the mixes there was a linear increment ($P<0.05$) in total sugar and ash content. This resulted in decline in the freezing point of mix. Similar findings have been reported and discussed by (**Fayed et al 2012)** in their frozen products mentioned above**.** It is noteworthy to mention that even at nearly similar TS level, Sherbet mixes were associated with lower FP as compared to Sorbets, even when compared at each specific level of water substitution with UFMP, as is illustrated in **Fig. 1.**

Rheological properties of Sherbet or Sorbet mix

The rheological results given in **Table 5** declared that, although the flow behavior index of Sherbet mix was not influenced by the level of water replaced with UFMP, the control Sorbet mix (without UFMP) showed the least value of (n) being 0.3895. Contrary, to the observed effect for Sherbet, the value of flow behavior index of Sorbet gradually increased to 0.5651, when UFMP replaced water portion of mix at 75% level. The proportional increment of water substitution with UFMP in Sherbet or Sorbet mixes was associated with gradual but considerable increase in their consistency coefficient, apparent and dynamic viscosities. This is due to the added solids as more UFMP was added **(Table, 4)**. Similar findings have been reported and discussed by **(Fayed et al 2012).** The results obtained in **Table 5** revealed that, addition of UFMP increased the viscosity, and consequently the mouth feel, of resultant frozen Sherbets as will be clearly correlated to the sensory evaluation results. Sherbet mixes were always distinguished with higher ($P<0.05$) value either of consistency coefficients, apparent or dynamic viscosity *versus* Sorbet at any specified UFMP level as replacement of water portion of mixes **(Table, 5)**. Moreover, the flow behavior indices (n) were in the range 0.5525 to 0.5405, indicating the pseudo plastic pattern of Sherbet mixes. This explains the clear convergence in the slope of the flow behavior curves **(Fig. 2)** in comparison with those of Sorbet mixes as shown in (**Fig. 3)**, where the relationship between shear rate and shear stress was non–linear indicating the non–Newtonian behavior of the experimental Sorbet mixes.

Physical properties of Sherbet or Sorbet

Table 6 indicates that the specific gravity of control Sherbet mix was 0.6980; such value tended to increase gradually to 0.7660, 0.7906 or 0.8633 for replacement level of water with UFMP of 25, 50 and 75% respectively. Likewise, significant ($P<0.05$) increase in the specific gravity of frozen Sorbet was noted. The rise was by 1.11, 1.26 or 1.30 fold when the water portion of mix was replaced with UFMP at 25, 50, and 75%, respectively. This phenomenon could be ascribed to the increase in solids contained in UFMP as against water (only total dissolved solids part) **(Table, 3).**

The products, whether Sherbet or Sorbet mixes prepared using UFMP at increasing level of replacement of water portion of mixes, were associated with significantly ($P<0.05$) higher overrun. The overrun in sherbet mixes was 1.22 fold higher when UFMP was used to replace water at 75% level. The increase in overrun in Sherbet was 1.08 and 1.16 fold when the replacement level of water with UFMP at the levels of 25 and 50% respectively. In case of Sorbet too, the overrun obtained was significantly ($P<0.05$) greater in product made using greater replacement of water with UFMP. The overrun in control and experimental product (75% replacement with UFMP) was 25.12% and 30.24% respectively; an increase of 1.20 fold over control product. The increase in the overrun in Sherbet and Sorbet mixes containing UFMP at higher values of replacement level for water portion of mix, can be explained by the increased viscosity of such mixes **(Table 5)**. **Fayed et al (2012)** reported that, in most cases, there is a direct relationship between the viscosity of the mixture and the overrun in the product made from.

Table 4. Physicochemical properties of mango Sherbet or Sorbet mixes fortified with 1% cooked pumpkin as affected by water replacement level with ultrafiltered milk permeate (UFMP)

Property	Water replacement level with ultrafiltered milk permeate							
	Nil (Control)		25%		50%		75%	
	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet
Total solids (%)	31.38^{d,a}	32.81^{d,a}	33.13^{c,a}	33.06^{c,a}	34.42^{b,a}	34.08^{b,a}	36.00^{a,a}	35.96^{a,a}
Total Sugars (%)	29.00^{d,b}	31.45^{d,a}	30.18^{c,b}	32.78^{c,a}	30.62^{b,b}	33.14^{b,a}	31.93^{a,b}	34.43^{a,a}
Reducing sugars (%)	3.35^{d,a}	0.85^{d,b}	4.15^{c,a}	1.65^{c,b}	5.00^{b,a}	2.50^{b,b}	5.84^{a,a}	3.34^{a,b}
Ash (%)	0.394^{d,a}	0.033^{d,b}	0.395^{c,a}	0.055^{c,b}	0.463^{b,a}	0.077^{b,b}	0.527^{a,a}	0.099^{a,b}
Acidity (%)	0.31^{a,b}	0.36^{a,a}	0.31^{a,a}	0.31^{a,a}	0.29^{b,a}	0.26^{c,a}	0.28^{b,a}	0.21^{d,a}
pH value	4.71^{a,a}	4.83^{a,a}	4.76^{a,a}	4.96^{a,a}	4.87^{a,b}	5.10^{a,a}	4.98^{a,a}	5.18^{a,a}
Specific gravity	0.957^{d,a}	0.747^{d,b}	1.074^{c,a}	0.832^{c,b}	1.132^{b,a}	0.954^{b,a}	1.254^{a,a}	1.008^{a,a}
Freezing point (°C)	- 3.4^{a,a}	- 3.1^{a,a}	- 3.8^{b,a}	- 3.6^{b,a}	- 4.3^{c,a}	- 4.1^{c,a}	- 4.7^{d,a}	-4.5^{d,a}

The letters before comma possess the factor of water replacement with UFMP. While those after comma possess the factor of the kind of dairy frozen dessert mix, respectively. The means with the same letter at any position did not significantly differ (P>0.05).

Table 5. Rheological parameters of mango Sherbet or Sorbet mixes fortified with 1% cooked pumpkin as affected by water replacement level with ultrafiltered milk permeate (UFMP)

Parameter	Water replacement level with ultrafiltered milk permeate							
	Nil (Control)		25%		50%		75%	
	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet
Consistency coefficient (K, dyne . s^n / cm^2)	17.47^{d,a}	7.22^{d,b}	19.01^{c,a}	7.73^{c,a}	20.98^{b,a}	10.76^{b,b}	23.31^{a,a}	14.15^{a,b}
Flow behavior index (n)	0.5525^{a,a}	0.3895^{d,b}	0.5467^{a,a}	0.4586^{c,b}	0.5647^{a,a}	0.5262^{a,b}	0.5405^{a,b}	0.5651^{a,a}
Correlation coefficient square	0.9988	0.9384	0.9993	0.9482	0.9996	0.9847	0.9992	0.9923
Apparent viscosity (η_a, dyne . s^{n-1} / cm^2)	1.251^{c,a}	0.3458^{c,b}	1.272^{c,a}	0.400^{c,b}	1.340^{b,a}	0.4337^{b,b}	1.427^{a,a}	0.513^{a,b}
Dynamic viscosity (cP)	125.13^{d,a}	34.58^{d,b}	127.20^{c,a}	40.00^{c,b}	134.11^{b,a}	43.37^{b,b}	142.65^{a,a}	51.30^{a,b}

The letters before comma possess the factor of water replacement with UFMP. While those after comma possess the factor of the kind of dairy frozen dessert mix, respectively. The means with the same letter at any position did not significantly differ (P>0.05).

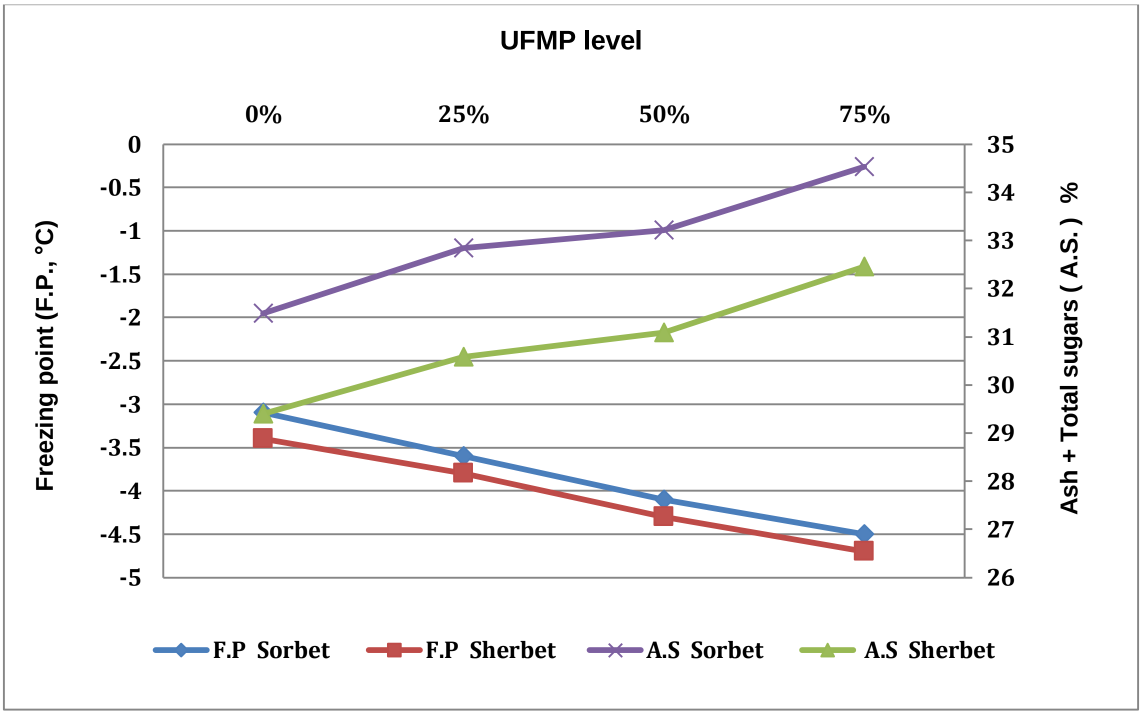

Fig. 1. Graph representing freezing point (F.P.) *versus* soluble mix component (ash plus total sugars, A.S.) content of mango Sherbets and / or Sorbets mixes with 1% cooked pumpkin as affected by water replacement level with ultrafiltered milk permeate (UFMP)

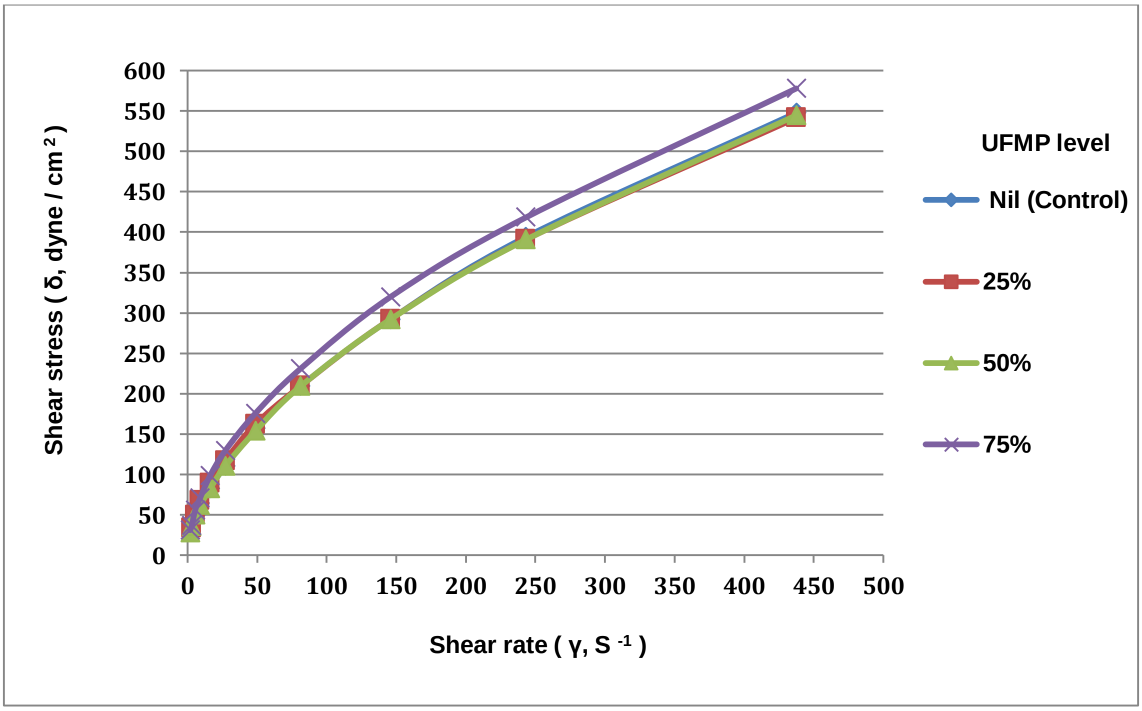

Fig. 2. Flow curves of control and experimental mango Sherbet mixes (containing pumpkin solids and UFMP)

Melting loss% (i.e. melting resistance of product) was assessed at various intervals of 15 min., starting at 15 min. till complete melting (i.e. 45 min.) The values of melting loss (%) of frozen Sherbet mix tended to decrease as the replacement level of water with UFMP was increased **(Table, 6)**. Similarly, for Sorbet, the melting loss (%) was lowered (less melting) when the replacement level of water portion of mix with UFMP was increased. It is of interest to note that complete melting loss (100%) took place at 30 min for control Sorbet as shown in the same **Table 6**. The positive effect of water replacement with UFMP can be explained by increasing the product's resistance to melting by looking at the freezing point of the mix, which decreases as the UFMP portion increases **(Table, 4)**. This means that there is an inverse relationship between the freezing point of the mix and the resistance of the resulting frozen product to melting. In this respect, it is worthy to explain that, there are two opposing forces occurs for melting resistance, (i) FP, (ii) mix viscosity. The increase in mix viscosity (with greater replacement level with UFMP in specific product) was greater than the lowering in FP – hence obtain greater melting resistance in that product!). Similar findings have been reported and discussed by **Fayed et al (2012).** The Sherbet is associated with greater resistant to melting as compared to Sorbet, when same level of replacement of water with UFMP is considered.

The curves drawn in the **Fig. 4** demonstrate the extent of the correlation in the ascending relationship between the level of replacement of mix water with UFMP and the level of TS and dynamic viscosity in the final product; be it Sherbet or Sorbet. The proportional water substitution of mixes with UFMP led to a gradual increase in both TS and dynamic viscosity of the resultant mixes. Generally, similar observations, towards the relation between TS and viscosity of mixes whether of ice cream made using UF-skimmed milk retentate *versus* UF-whey protein concentrate or frozen yoghurt, have been reported and discussed by **Fayed et al (2012).** Moreover, it is worthwhile to mention that Sherbets possessed higher values of dynamic viscosity as compared to Sorbets, when compared at specific level of water substitution with UFMP in relevant mixes **(Fig. 4)**. This suggests that the protein supplied by presence of SMP (about 35% protein) in Sherbet mixes, conferred the desired viscosity as compared to the increased sugar (5% higher than in Sherbet, but devoid of milk solids) present in Sorbet mixes.

Sensory quality of Sherbet or Sorbet

The sensory scores of Sherbet or Sorbet confirmed use of UFMP to replace up to 50% of water in the mix, failed to significantly ($P>0.05$) affect the consistency score of both products. At the maximum level of replacement of water with UFMP (i.e. 75% level), frozen dessert (whether Sherbet or Sorbet) had higher ($P<0.05$) mean score for consistency when compared to which the control or even product with 25 and 50% replacement levels.

Irrespective of the type of frozen dessert (i.e. Sherbet, Sorbet), the product made using maximum level of water replaced with UFMP (i.e. 75%) was associated with higher mean flavor score ($P<0.05$) as compared to those having lower replacement levels (25, 50%) and control product. The sensory scores for Sherbets and Sorbets depicted in **Table 7** reveals that, products prepared using UFMP at 50% replacement level and control (no replacement of water) had flavor scores that was at par with each other. It is worthy to mention that, the mango used was rich in flavor so that the taste of added pumpkin was completely masked, especially since the percentage of mango pulp substitution with it did not exceed 10% as it was deliberately designed in advance in the previous work of mango drink carried out by **Eid et al (2019)**.

Likewise, superior melting quality score was noted for Sherbet or Sorbet prepared using UFMP used at 75% level of water replacement ($P<0.05$) as compared to those having lower replacement levels (25, 50%) and control product **(Table, 7)**. The melting quality in the mouth is considered a key sensory feature; whereas the mouth feels the resulting frozen product as was clearly demonstrated through sensory arbitration.

Since the frozen desserts (Sherbets, Sorbet) prepared using maximum level of UFMP (i.e. 75% replacement for water portion of mixes) had significantly ($P<0.05$) superior scores for consistency, flavor and melting quality, such products had significantly ($P<0.05$) greater score for total sensory score when compared to other products (25 and 50% replacement of water, and control product).

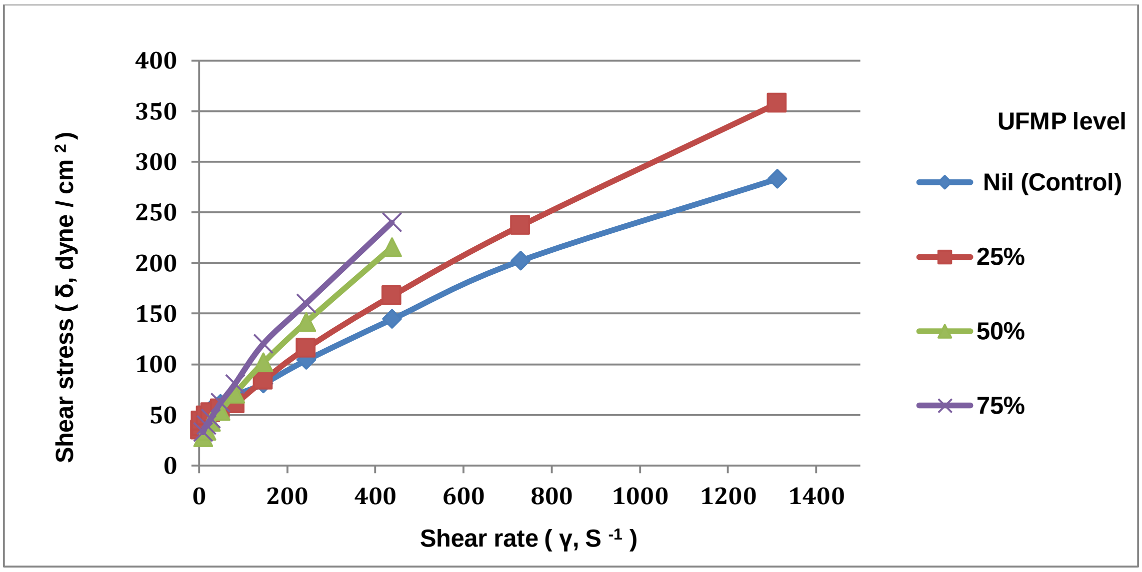

Fig. 3. Flow curves of control and experimental mango Sorbet mixes (containing pumpkin solids and UFMP)

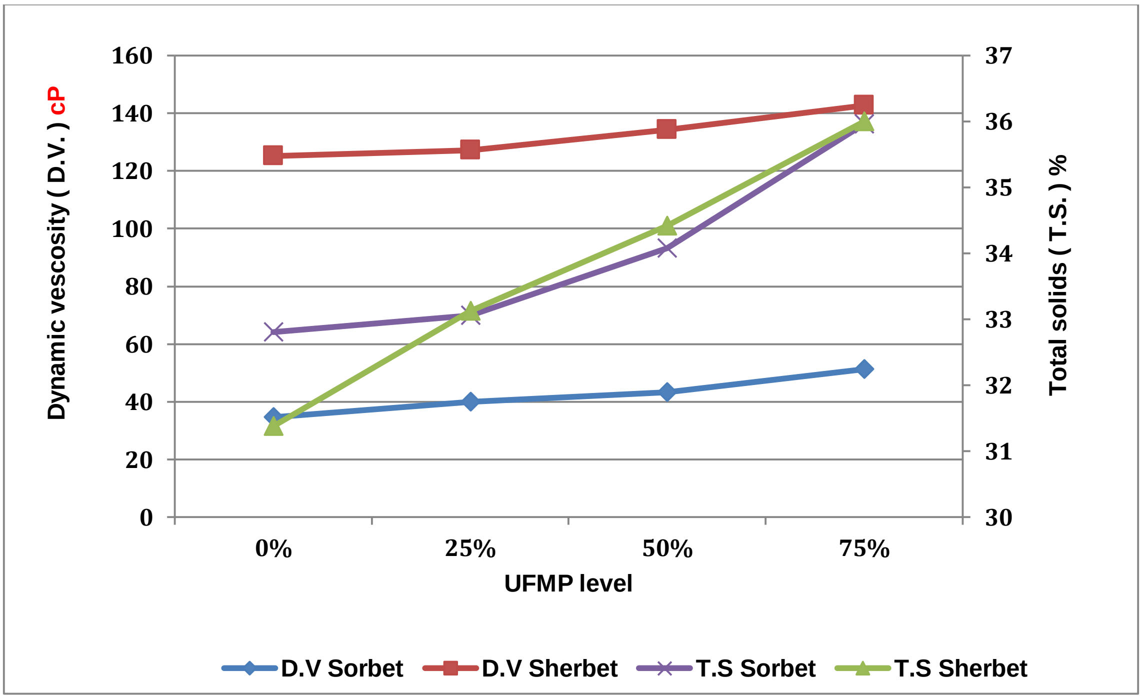

Fig. 4. Dynamic viscosity (cP) and TS content of control and experimental mango Sherbets and Sorbets mixes as affected by the presence of pumpkin solids and UFMP

Table 6. Physical properties of frozen mango Sherbet or Sorbet fortified with 1% cooked pumpkin as affected by water replacement level with ultrafiltered milk permeate (UFMP)

Property	Water replacement level with ultrafiltered milk permeate							
	Nil (Control)		25%		50%		75%	
	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet
Specific gravity	0.6980^{d,a}	0.5970^{d,b}	0.7660^{c,a}	0.6615^{c,b}	0.7906^{b,a}	0.7503^{b,b}	0.8633^{a,a}	0.7739^{a,b}
overrun %	37.12^{d,a}	25.12^{d,b}	40.22^{c,a}	25.77^{c,b}	43.17^{b,a}	27.15^{b,b}	45.25^{a,a}	30.24^{a,b}
Melting loss % after:								
15 min	15.7^{a,b}	21.4^{a,a}	13.6^{b,b}	20.3^{b,a}	10.4^{c,b}	18.7^{c,a}	8.1^{d,b}	14.5^{d,a}
30 min	40.5^{a,b}	100^{a,a}	37.1^{b,b}	100^{a,a}	33.4^{c,b}	100^{a,a}	30.3^{d,b}	100^{a,a}
45 min	100	___	100	___	100	___	100	___

The letters before comma possess the factor of water replacement with UFMP. While those after comma possess the factor of the kind of dairy frozen dessert mix, respectively. The means with the same letter at any position did not significantly differ (P>0.05).

Table 7. Sensory scores of frozen mango Sherbet or Sorbet fortified with 1% cooked pumpkin as affected by water replacement level with ultrafiltered milk permeate (UFMP)

Sensory attribute	Water replacement level with ultrafiltered milk permeate							
	Nil (Control)		25%		50%		75%	
	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet
Consistency (out of 40 point)	35.90^{b,a}	35.00^{b,a}	35.20^{b,a}	32.80^{b,b}	35.80^{b,a}	33.90^{b,b}	37.90^{a,a}	38.40^{a,a}
Flavor (out of 50 point)	44.60^{b,a}	42.50^{b,b}	42.00^{b,a}	42.10^{b,a}	43.70^{b,a}	42.10^{b,a}	47.50^{a,a}	48.60^{a,a}
Melting quality (out of 10 point)	8.60^{b,a}	8.40^{b,a}	8.20^{b,a}	7.80^{b,b}	8.60^{b,a}	8.10^{b,a}	9.40^{a,a}	9.50^{a,a}
Overall acceptability (out of 100 point)	89.10^{b,a}	85.90^{c,b}	85.40^{c,a}	82.70^{c,a}	88.10^{b,a}	84.10^{c,a}	94.80^{a,a}	96.50^{a,a}

The letters before comma possess the factor of water replacement with UFMP. While those after comma possess the factor of the kind of dairy frozen dessert mix, respectively. The means with the same letter at any position did not significantly differ (P>0.05).

Table 8. Antioxidant activity of mango Sherbet or Sorbet mix with 1% cooked pumpkin as affected by water replacement level with ultrafiltered milk permeate (UFMP)

Property	Water replacement level with ultrafiltered milk permeate							
	Nil (Control)		25%		50%		75%	
	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet	Sherbet	Sorbet
Total phenolic (mgGAE/g)	9.49^{d,a}	8.27^{d,b}	10.32^{c,a}	9.10^{c,b}	11.15^{b,a}	9.93^{b,b}	11.98^{a,a}	10.76^{a,b}
Total flavonoids (mg QE /g)	24.37^{a,a}	23.93^{a,a}	24.45^{a,a}	24.01^{a,a}	24.52^{a,a}	24.08^{a,a}	24.59^{a,a}	24.15^{a,a}
DPPH radical scavenging activity %	7.47^{d,a}	2.29^{d,b}	10.23^{c,a}	5.06^{c,b}	13.00^{b,a}	7.82^{b,b}	15.76^{a,a}	10.59^{a,b}

The letters before comma possess the factor of water replacement with UFMP. While those after comma possess the factor of the kind of dessert mix, respectively. The means with the same letter at any position did not significantly differ (P>0.05).

Physiological advantages resulting from the incorporation of UFMP towards the antioxidant activity

The results present in **Table 8** revealed that, although TF was not influenced, the proportional water substitution with UFMP caused significantly gradual increment in both TP and RSA values either of Sherbets or Sorbets. Moreover, Sherbets were always distinguished from Sorbets with their significant high RSA %. That could be ascribed to the presence of SMP in their recipe, which possessed a considerable protein reducing value. Similar confirmations were done by **Hofi et al (1983).**

CONCLUSION

The forgoing results led satisfactory to conclude that, it could be successfully produced Sherbet or Sorbet using 9% mango plus 1% cooked pumpkin; as valuable addition; and furtherly water replacement with 75% ultrafiltered milk permeate, those of many impressive health benefits to meet the intended health purposes, consequentialist according to the sensory acceptability, those *en* route to innovate frozen desserts. This ensures that the product is supplied through such natural additional sources of antioxidant activity to elevate its physiological benefits and *en* route to innovate products.

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إضافة قيمة إلى الحلوي المجمدة من خلال دمج جوامد القرع العسلى وراشح اللبن بالترشيح الفائق

[66]

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الموجـــــــز

تم إعداد مشروبات لبنية مجمدة (جرانيتا اللبن) ومثلوجات مائية (الجرانيتا) من النوع المنكهه بالفاكهة الطبيعية تحتوى على 9٪ لب مانجو طازج، كما هو، 1 ٪ قرع مطبوخ. وتم استبدال كمية الماء اللازمة لكليهما براشح اللبن الناتج بالترشيح الفائق بنسب 25 أو 50 أو 75٪. أوضحت النتائج بشكل منفصل لكل من الخامات الرئيسية المستخدمة ، احتواء القرع المطبوخ على نسب اعلي في كلا من الرطوبة والنيتروجين الكلي ومركبات الفينول الكلية بالإضافة إلي قيم نشاط مسك (كسح) الشوارد ونسب أقل في مركبات الفلافونويد الكلية ومحتوي الكربوهيدرات مقارنة بلب المانجو. في حين ادي استبدال ماء المخلوط براشح اللبن في كلا من المشروبات اللبنية المجمدة والمثلوجات المائية الي زيادة المواد الصلبة الكلية والسكريات الكلية والمختزلة وكذلك المحتوى من الرماد. ولكن لم تتأثر معنويا نسبة الحموضة وقيمة الأس الهيدروجيني للمخاليط بإضافة راشح اللبن على الرغم من أن نسبة الحموضة في المثلوجات المائية قد زادت بشكل كبير بإضافة الراشح. كما إنخفضت نقطة تجمد مخاليط المشروبات اللبنية المجمدة والمثلوجات المائية تدريجيًا بزيادة مستوى الاستبدال بالراشح، على الرغم من أن مؤشر سلوك التدفق لم يتأثر في المشروبات اللبنية المجمدة ولكن زاد في المثلوجات المائية طرديا بإضافة الراشح وارتبطت الزيادة النسبية لمستوى الراشح في المخاليط بزيادة معنوية تدريجيًا في معامل القوام، واللزوجة الظاهرية والديناميكية، وقيم مركبات الفينول الكلية ونشاط مسك الشوارد لكلا من المشروبات اللبنية المجمدة والمثلوجات المائية. علاوة على ذلك، أدى استبدال ماء المخلوط براشح اللبن إلى زيادة الوزن النوعى للمخاليط سواء قبل أوبعد التجميد بالإضافة إلى زيادة نسبة الريع المتحصل عليها وتعزيز مقاومة المنتج النهائي للانصهار. علاوة على ذلك، فإن إستبدال الماء براشح اللبن بنسبة 75% في أى من المشروبات اللبنية المجمدة أو المثلوجات المائية ادي للحصول علي أعلى درجات التحكيم لجميع الخواص الحسية. وأخيرًا، تشير النتائج السابقة إلى إمكانية تصنيع منتج جديد يلبي الأغراض الصحية المقصودة من خلال استبدال 10٪ من لب المانجو بجوامد القرع العسلي والذي يتميز بالعديد من الفوائد الصحية بالإضافة إلى استخدام راشح اللبن الناتج بالترشيح الفائق كمصدر للإليكتروليتات الأساسية كبديل بنسبة 75٪ من كمية الماء المستخدمة كنهج جديد لانتاج حلوى مجمدة مثل المشروبات اللبنية المجمدة والمثلوجات المائية.