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Effect of Fortification with Germinated Garden Cress Seeds Paste *(Lepidium sativum)* and Using Ultrasound Technique on the Properties of Ice Milk

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THE influence of adding germinated garden Cress seeds paste (GCSP) and using ultrasound technique on the physico-chemical, rheological, and organoleptic properties of ice milk were studied. Moreover, antioxidant, phenolic compounds, minerals and vitamins contents in ice milk mixtures, and their resultant frozen products were also determined. Partial substitute of GCSP at levels of 5, 10, and 15% was added to the mixtures of experimental treatments without adding a stabilizer/emulsifier and using ultrasound techniques without pasteurization. A control treatment was contained 4% fat, 15% sugar, 12% MSNF%, and 0.35% stabilizer/emulsifier. One of the two treatments of the control mixture was pasteurized, while the other treatment was performed by ultrasound technology. Results indicated that, dry matter, ash, total protein, fiber, and carbohydrates were significantly ($P<0.05$) increased in the mixtures contained GCSP as the levels of addition increased. No significant differences were found in the contents of fat, titratable acidity or pH value among the GCSP treatments ($P>0.05$). Data also showed significant ($p<0.05$) differences between control treatments and the other GCSP treatments in minerals (Fe, P, K, Ca, Mg, Zn and Mn) and vitamins (C, E, A, K and folic acid) contents .On the other hand; control treatments had the lowest values of antioxidant and phenolic compounds. All sensory properties of samples were accepted; except the treatment containing 15% GCSP had flavor defects. Ice milk samples which had GCSP up to 10% (without adding stabilizer/emulsifier and using ultrasound technology) gained higher sensory properties compared to the control treatments. It can be recommended that the ice milk samples were higher quality by the addition of GCSP up to 10% with applied ultrasound technique, without adding a stabilizer/emulsifier.

Keywords: Ice milk, Germinated garden cress seeds, Ultrasound technique.

Introduction

The goal of emerging food processing technologies is to provide foods that are tasty, safe, nutritious, healthy, and little processed. In order to avoid modifying the flavor or nutritional value of foods during production; researchers have turned to develop food technologies such as non-thermal technologies. High-intensity ultrasound (HIU) is a promising new technology that was created with the economy, simplicity, and energy efficiency in mind. HIU offers a great potential to improve, control, and accelerate processes without damaging the quality of food and dairy products (Dolatowski et al., 2007; Carrillo-Lopez et al., 2021).

Using of ultrasound in food processing has shown that heat has a deleterious influence on thermo-labile substances such as yogurt (Perez-Grijalva, et al., 2017). The impact of HIU on dairy systems has become a major topic technology due to its function in increasing food safety and delaying food decomposition

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(Balthazar et al., 2019). Its effects on microbes have been intensively researched as a technique of preservation (Knorr, et al., 2004; Patist and Bates, 2008). In addition; milk enzymes are inactivated (Villamiel & de Jong, 2015). One of the most important applications of ultrasound is in fermentation processes (Barukči´c et al., 2015) and the creation of functional fermented beverages; where sensory characteristics are significantly improved (Jeliči´c et al., 2012).

Ice milk consumption has risen as a result of its good nutritional qualities, such as a reduced fat content compared to high fat ice cream. The fat level of ice milk must not be less than 3% (Atallah & Barakat et al., 2017). Ice milk is a frozen blend of milk components (proteins, carbohydrates, fats, minerals and vitamins as well as stabilizers, sweeteners, flavors and emulsifiers. It is defined as partially frozen foam with a 40–50 percent air component by volume. It has a higher nutritional, biological value and calories (Egyptian Standard, 2005).

Stabilizers are a type of substance that, despite its low concentration in the final product, provides unique and vital functions. A stabilizer's primary function is to minimize the amount of free water in an ice milk mix by binding it as "water of hydration" or immobilizing it inside a gel structure, resulting in a product with a good body, gradual meltdown, heat shock and smooth texture (Goff, 1997). It also prevents air bubbles from collapsing, resulting in better flavor dispersion and release. Also, emulsifiers used in the production of ice cream or ice milk serve a variety of purposes, including reducing whipping time, controlling fat instability, improving texture smoothness, increasing resistance to melting and shrinkage, and improving dryness (Marshall et al., 2003).

Garden cress seeds are an excellent source of antioxidants, minerals, fatty acids, and amino acids. It can be used to make a variety of fortified dairy and food items that are both nutritional and functional (Singh & Pashwan, 2017). It aids in the prevention of a variety of ailments as well as increases hemoglobin levels in patients. It possesses a variety of therapeutic effects, including anti-diabetic, anti-inflammatory (Shail et al., 2016); hepatoprotective, and anti-microbial qualities (Bhaswati & Rekha, 2020). It is also rich in the guar gum, which has good properties as a stable (Razmkhah et al., 2016).

Garden cress germination enhances nutrition, as well as has pleasant sensory characteristics. It. can be germinated to functional health advantages can be reaped by adding them to a variety of products (Rajshri & Haripriya, 2018). (Vaishnavi & Radhna, 2020) found that the garden cress seed germinated is higher in protein, fiber, many minerals, vitamins, and antioxidants than the seeds. For all of the above, the aim of the present study was to produce a functional ice milk that is low in calories and rich in nutritional value and antioxidants. Another aim is improving the rheological, physicochemical, and sensory properties of the final product.

Materials and Methods

Materials

Fresh buffalo's milk was obtained from an experimental station at Mahalet Moussa, Animal production Research Institute, Egypt. Imported skim milk powder (SMP) (Holland), commercial grade granulated sugar cane, garden cress seeds and vanilla powder were purchased from the local market and maintained at room temperature (32°-35°C). Water was sprayed on the seeds to keep them moist. Seeds required 48 hours to germinate (about 1 - 1.5 cm long). The seeds were then mashed well with a hand blender until a very smooth paste (Vaishnavi & Radhna, 2020).

Preparation of ice milk

The control (C_1) mix was standardized to contain 4% fat, 12% S.N.F, 15% sugar, 0.35% stabilizer/emulsifier, and pasteurization at 85̊C for 1 min., while the other control (C_2) mix was unpasteurized but was treated by the ultrasonic device at a wavelength of 25 MHz for 20 minutes and that in all treatments. Germinated Garden Cress seeds paste (GGSP) was used in percentages of 5, 10 and 15% for T_1, T_2 and T_3 treatments, respectively. These treatments mix without adding a stabilizer/ emulsifier as shown in Table 2. Mixes of the three treatments were unpasteurized and unhemoginized but were treated on the ultrasonic device and aged at the same temperature for 12 hr. After aging, 0.01% vanilla powder was directly added before being frozen in a batch freezer system (Qutofrigor E.21.8, Co., Paris). The frozen ice milk was packed in plastic cups (100 mL) and hardened at -20 °C for 24 hr before analyses.

TABLE 1. The composition of garden Cress seeds and germinated garden seeds paste which used in preparation of ice milk formula.

Character assessed	Garden Cress seeds	Germinated garden Cress seeds paste
Moisture %	5.08[b]	5.84[a]
Protein %	21.54[b]	25.23[a]
Fat %	20.85[b]	5.63[a]
Ash %	4.01[b]	5.14[a]
Fiber %	8.17[b]	12.89[a]
Carbohydrates %	40.35[b]	45.27[a]
Ca mg	189.11[b]	283.33[a]
Fe mg	16.04[b]	107.92[a]
P mg	476.08[b]	610.852[a]
Mg mg	178.42[b]	382.17[a]
Zn mg	2.68[b]	6.13[a]
Mn mg	0.55[b]	1.72[a]
K mg	1217.23[a]	1621.11[a]
Vitamin C mg	56.84[b]	138.12[a]
Vitamin E mg	0.7[b]	2.8[a]
Vitamin A mg	0.36[b]	2.18[a]
Vitamin K mg	0.54[b]	1.48[a]
Folic acid (B_9) µg	80.7[b]	132.4[a]
Total phenolic content	93.21[b]	106.17[a]
DPPH %	166.22[b]	238.94[a]
Titratable acidity %	0.12[a]	0.17[a]
pH value*	6.25[b]	6.09[a]

*Determined in 20% aqueous solution (W/V)

Methods

Moisture, fat, total nitrogen, ash, titratable acidity and fiber contents were determined according to AOAC (2016). Vitamin E was determined according to the methods described by Pyka, and Sliwiok. Ascorbic acid, vitamin A, K, folic acid and the mineral contents were determined according to the method described by the AOAC (2016) using an atomic absorption spectrometer. The pH value was measured using a pH meter using Lab. pH meter with a glass electrode, (Hanna digital pH meter). The carbohydrate content of all samples was calculated by difference.

The specific gravity values of the ice milk mixes or the final frozen product, the weight per gallon (kg) and freezing point were measured as described by (Marshall & Arbuckle,1996). The whipping ability of ice milk mixes was determined as mentioned by (Baer et al., 1999) using a home type mixer. The overrun percent was calculated as mentioned by (Wild & Clark, 1996). Melting resistance of resultant ice milk was examined according to (Segall & Goff, 2002). The viscosity was carried out as described by (Toledo, 1980) using Brookifield DV- E viscometer, 2001.

The antioxidant activity was evaluated by the stable 2,2-diphenyl-1-picryl-hydrazyl (DPPH, Sigma Aldrich, Germany) radical scavenging method as described by (Matthus, 2002). Flow time was measured through a 50-ml pipette (Arbuckle, 1986). Total phenolic compounds were determined by the Folin-Ciocalteau method (Ebrahimzadeh et al., 2008). The ice milk sample was tempered to -15°C to -12°C before sensory evaluation. Scoring was carried out according to the scheme of (Khalil and Blassy, 2019). Three replicates were done. The obtained data were statistically analyzed according to statistical analyses system user's guide (SAS, 2006).

Results and Discussion

Results of ice milk mix

Table 1 shows the chemical composition, antioxidants, and phenolic compounds in each of the cress seeds and germinated cress seed paste (GGSP). It was observed that the germination of cress seeds increased protein, ash, carbohydrates, fiber, minerals (Ca, Fe, P, Mn, Mg, Zn), vitamins (C, K, A, folic acid), total antioxidants (DPPH), and total phenolic compounds; a significant increase of 0.0001 compared to cress seed (GS).

TABLE 2. Formula of different ice milk recipes with germinated garden cress seeds and ultrasonic technology (g/kg mix).

Ingredients (g)	Treatments				
	C_1	C_2	T_1	T_2	T_3
Sugar	150	150	150	150	150
Ggcp	0.0	0.0	50	100	150
Whole milk (6%fat)	803	803	751.6	696.4	641.2
Skim milk powder	43.5	43.5	48.4	53.6	58.8
Stabilizer&emulsifier	3.5	3.5	0.0	0.0	0.0

Vanilla 0.1 g/kg.

C_1: The control with pasteurization of the mixture and without additives.

C_2: Control unpasteurization of the mixture and with ultrasonic technology and without additives.

$T_{1,2,3}$: The treatments with fortified of germinated garden seeds paste 5,10and 15% respectively also,unpasteurization of the mixture but use ultrasonic technology .

Also, potassium, vitamin E, and acidity were increased in GCSP than in CS, but it was not a significant increase. Also, K, vitamin E, and acidity increased in GGSP than in CS, but it was a non-significant increase, while the fat and pH values were decreased. These results were agreed with what was concluded by Rajshri & Haripriya (2018), AL-Sayed et al. (2019) and Vaishnavi & Radhna (2020).

Germination is a biological process that occurs when a seed transforms from a dormant to a vital active state. It's a simple procedure that's been shown to boost food's nutritional value. (Limbachiya & Amin, 2015) .Increased lipolytic enzyme activity during germination led to hydrolyze lipid components into fatty acids and glycerol, which could explain the decrease in fat content (Chinma et al, 2009; Rajshri & Haripriya., 2018) observed that germination can improve protein content and dietary fiber in legumes in several experiments. Carbohydrates, particularly starch, are the most important reserve element in most seeds, according to (Bewley and Black, 1994) when seeds are soaked in water, the mucilage on the seed coat swells and encase the entire seed in a clear, colorless covering. The mucilage is made up of cellulose and polysaccharides found in uronic acid. As a result, soaking seeds overnight before bursting them; enhanced the crude fiber content. Furthermore, soaking and sprinkling seeds, followed by germination, increased the crude fibre content of the seeds to the highest level among the treatments (Vaishnavi and Radhna, 2020). Mobilization of store carbohydrates happens during early germination; once mobilized, the high molecular weight carbohydrates are transformed into soluble forms, such as sucrose, glucose, and fructose, which are easily transported to places where they are required for growth. The rise in total carbohydrate content on germination can be attributable to the previously stated notion, according to (Mayer and Poljakoff-Mayer, 1975). Germination is reported to be associated with an increase in vitamin concentrations and bioavailability of trace elements and mineral found that germination improves vitamin C content. (Rajshri & Haripriya, 2018; Dipika et al., 2013). By germination; the total phenolic content of the garden cress seed increased. A variety of metabolic events occur during seed sprouting, resulting in radical changes in primary and secondary metabolite composition, which could affect intrinsic phenolic compound profile and antioxidant activity (Jian et al., 2009). Germination improves the nutraceutical properties of Garden Cress Seeds by boosting phenolic component concentration as well as antioxidant activity (Rajshri & Haripriya, 2018).

Table 3 shows the composition and properties of ice milk mixes made with different levels of germinated garden cress seeds paste (GCSP) treated with ultrasound technique (UT). The results indicated that the GCSP-fortified sample had an significantly increase contents of dry matter, ash, total protein, fiber, and carbohydrates (P< 0.0001) while the fat and pH value no significantly increased by increasing the level of GCSP. This was mainly due to differences in the chemical composition of GCSP used (Table 1). Titratable acidity tended to slightly decrease (no significantly) with adding GCSP in ice milk formula. It could be due to the lower acidity and higher pH values of GCSP in Table 1.

TABLE 3. Chemical composition of ice milk mixes with the fortified germinated garden cress seeds paste (GCSP) and Ultrasound technology.

Property	Treatments				
	C_1	C_2	T_1	T_2	T_3
Dry matter %	31.71[d]	31.55[d]	35.23[c]	39.31[b]	44.67[a]
Total protein %	4.76[d]	4.75[d]	5.99[c]	7.25[b]	8.51[a]
Fat %	3.95[b]	4.00[b]	4.25[ab]	4.42[a]	4.55[a]
Ash %	1.03[d]	1.01[d]	1.24[c]	1.53[b]	1.80[a]
Fiber %	-	-	0.63[c]	1.28[b]	1.92[a]
Carbohydrates %	21.97[d]	21.79[d]	23.42[c]	24.83[b]	27.89[a]
pH value	6.18[a]	6.19[a]	6.21[a]	6.23[a]	6.25[a]
Titratable acidity %	0.18[a]	0.178[a]	0.175[a]	0.174[a]	0.172[a]

See details in Table 2.

Table 4 shows the effect of GCSP and US on some properties of ice milk mixes. The specific gravity, weight per gallon and freezing point were gradually increased with the increase the GCSP. The lower freezing point in treatments with GCSP could be due to its higher lactose and ash contents. The freezing point is affected by the amount, type and molecular weight of the solutes in the mix (Marshall et al, 2003; El-Dardiry et al., 2018). It was also found that the control treatment with ultrasonic (C_2) led to a lower freezing point than the control- treated with pasteurization (C_1). As appeared in Table 4, treatments of the US trend with GCSP significantly increased (p<0.0001) the flow time and viscosity of the mixes. The differences in flow time and viscosity values of controls and treatments with GCSP could be due to the differences in the composition of both materials (Table 1). GCSP is known to contain a high amount of starch fiber which is able to gelatinize during the US and therefore, may increase the viscosity and flow time of the ice milk mix. Similar results were reported by El-Dardiry and Gab-Allah (2016) and El-Dardiry et al., 2018). Also, the gum present in the GCSP led to an increase in viscosity and flow time in the treatments. Behnia et al (2013) andHassan et al. (2015) reported that cress seed gum can bond water in samples and consequently increase the viscosity. It could be also noted that all samples that were treated with the ultrasound, including the C_2 treatment, showed that the US promotes whey coagulation, fat-drop reduction, water-holding capacity, and increases viscosity (Akdeniz & Akalın, 2019; Carrillo-Lopez et al., 2021).

Regarding the minerals and vitamins contents of ice milk mixes, data are given in Table 5 indicate that the US with GCSP caused significant (P<0.05) increase in the Ca, Fe, P, Mg, Zn, Mn, and K contents. Also the addition of GCSP led to an increase in vitamins content (C, E, A, K and folic acid), while the increase in vitamin C in C_2 is due to the treatment of the mix with ultrasound without pasteurization, which preserved part of it, as is observed in C_1 treated with pasteurization.

With regard to phenolic compounds and total antioxidants, their values are present in Table 6, which shows that the addition of GCSP leads to a significant increase (p<0.0001) in phenol compounds and antioxidants with an increase in the percentage of addition, and this is attributed to their increase in GCSP formula in Table 1. On the contrary, there were no significant differences in the antioxidants or phenolic compounds in each of the two control treatments (C_1 and C_2).

Figure 1 depicts the whipping ability of ice milk mixes with various GCSP ratios. At first, all treatments had a higher whipping ability. The current figure clearly shows that the GCSP was better at whipping ability than the control, particularly T_3. This could be related to cress seed's foaming, stabilizing and emulsifying capabilities. These results seem by It was also found that the use of the ultrasonic technique improved the whipping ability, so there were significant differences between the control sample treated by the ultrasound device and the control sample treated with ordinary pasteurization.

TABLE 4. Physical properties of ice milk mixes which fortified by germinated garden seeds paste and Ultrasound technology.

Property	Treatments				
	C_1	C_2	T_1	T_2	T_3
Specific gravity	0. 9495[a]	0.9643[a]	0.9999[a]	1.0086[a]	1.0189[a]
Weight (Kg)/ gallon	3.6015[a]	3.6576[a]	3.7926[a]	3.8256[a]	3.8647[a]
Freezing point C̊	-2.97[a]	-2.99[a]	-3.01[a]	-3.03[a]	-3.05[a]
Flow time (sec.)	121.16[a]	108.24[b]	100.52[c]	96.37[d]	90.43[e]
Viscosity (cP)	813[e]	924[d]	1146[c]	1302[b]	1485[a]

See details in Table 2.

TABLE 5. Minerals and Vitamins of ice milk mixes which fortified by germinated garden seeds paste and Ultrasound technology.

Properties		**Treatments**				
		C_1	C_2	T_1	T_2	T_3
Minerals (mg/100g mix)						
Ca	mg	142.72[d]	142.72[d]	155.67[c]	169.81[b]	184.08[a]
Fe	mg	0.097[d]	0.097[d]	5.44[c]	10.88[b]	16.28[a]
P	mg	93.21[d]	93.21[d]	122.43[c]	153.08[b]	183.63[a]
Mg	mg	24.83[d]	24.83[d]	43.21[c]	60.23[b]	79.46[a]
Zn	mg	0.176[d]	0.176[d]	0.486[c]	0.755[b]	1.061[a]
Mn	mg	0.0144[d]	0.0144[d]	0.098[c]	0.186[b]	0.271[a]
K	mg	142.30[d]	142.30[d]	221.06[c]	302.11[b]	383.17[a]
Vitamins (mg/100g mix)						
Vitamin C	mg	1.36[e]	2.27[d]	8.95[c]	15.88[b]	22.76[a]
Vitamin E	mg	0.06[b]	0.06[b]	0.19[b]	0.33[a]	0.47[a]
Vitamin A	mg	0.052[d]	0.052[d]	0.161[c]	0.268[b]	0.377[a]
Vitamin K	µg	0. 31[d]	0. 31[d]	74.29[c]	148.28[b]	222.30[a]
Folic acid (B_9)	µg	6.84[a]	6.84[a]	13.41[a]	19.58[a]	26.41[a]

See details in Table 2.

TABLE 6. Total phenolic content and antioxidant activity of ice milk mixes which fortified by germinated garden seeds paste and Ultrasound technology.

Treatments				
C_1	C_2	T_1	T_2	T_3
		Total phenolic content *		
0.0071[d]	0.0071[d]	5.315[c]	10.626[b]	15.928[a]
		Antioxidant activity **		
9.01[d]	9.00[d]	19.98[c]	32.94[b]	44.84[a]

See details in Table 2.
*equivalent mg Gallic acid/100gm.
**% (DPPH: 2, 2-dihpenyl-1-picrylhydrazyl).

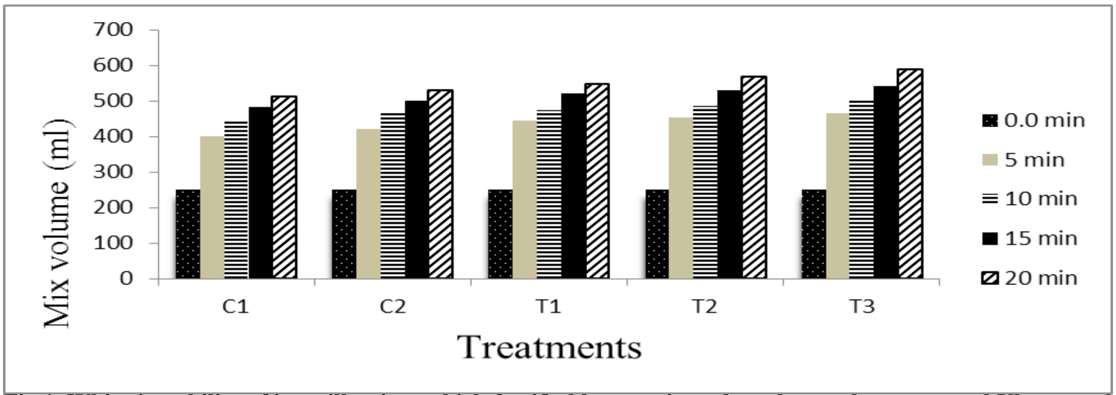

Fig 1. Whipping ability of ice milk mixes which fortified by germinated garden seeds paste and Ultrasound technique.

Properties of resultant ice milk

The results presented in Table (7) revealed that the physical properties of fortified ice milk were affected by different levels of GCSP. The specific gravity and weight per gallon of the final ice milk decreased with the gradual increase of SMP and the increase in the level of GCSP in the ice milk mixture, noting that the decrease in specific gravity and weight per gallon was not significant,; which could be explained on the basis of the increased overrun percent gained ($p<0.0001$) in the resultant ice milk. Also, as the level of GCSP content in the mix increased; the melting resistance was significantly increased, and ice milk contains of 15% GCSP substitution exhibited the highest melting resistance ($p<0.001$). The increase in the resistance of melting in the ice milk containing a higher ratio of the GCSP is due to the content of the cress seeds having a high ratio of gums, which increases the stability of the ice milk and thus increases its melting resistance. It is noteworthy to mention that, there is a positive relationship between the melting resistance and freezing point of ice milk. On the other hand, the latter has a reverse correlation to the lactose and ash contents of the mix. El-Dardiry et al. (2018) reported similar findings.

Table 8 shows the effect of using the ultrasound technique without pasteurization and the effect of fortification with different ratio of GCSP on the sensory evaluation of ice milk samples. It could be noticed that color was not affected by the addition of GCSP up 10% addition, but the T_3 treatment containing 15% GCSP had light caramel color. while the body and texture & melting resistance were improved. With regard to the body & texture and resistance to melting; the ice milk fortified with GCSP and not added stabilizer/emulsifier it was improved, as it gained higher points compared to the control treatments with a stabilizer. This agreed with Abd El-Salam et al. (2019) and Hassan et al. (2015). It could also observed that C_2 which treated with ultrasound with the addition of stabilizer/emulsifier was better in body& texture, and melting resistance to fusion than C_1 treated with pasteurization with only a stabilizer/emulsifier additive. This is due to the fact that the ultrasound has the effect of naturalizing the ice milk mix (Yang et al., 2021; Naeim, 2019; Martini & Walsh, 2012; Chinma et al., 2009). Similarly, it can be said that the treatments supported by different percentages of GCSP, without adding a stabilizer/emulsifier, are also among the reasons for improving the body& texture, and melting resistance of the treatment with the ultrasound. With regard to flavor, we noted that the treatments fortified with GCSP up to 10% had a good flavor similar to the two control treatments. As for T_3 treatment, the taste and flavor of cress love appeared, and it was not acceptable.

Noting the feeling of greasiness in all the treatments treated with ultrasound, including the C_2 treatment. Ultrasound works the role of naturalization and reduces the large granules of fat & protein then distributes them efficiently in the mixture, which is consistent with each. Mortazavib & Tabatabai (2008) showed that 20-min pulsed ultrasonic of ice creams resulted in the best sensory flavor, texture, and mouth feel evaluations. It is evident in Table 8, the ice milk made from a mix containing GCSP up to 10% and without adding stabilizer/emulsifier which treated with ultrasound without pasteurization; has superior in its total score of sensory properties.

TABLE 7. Physical properties of resultant ice milk which fortified by germinated garden seeds paste and Ultrasound technique.

Property	Treatments				
	C_1	C_2	T_1	T_2	T_3
Specific gravity	0.6912[a]	0.6903[a]	0.6899[a]	0.6884[a]	0.6872[a]
Weight per gallon	2.6217[a]	2.6183[a]	2.6164[a]	2.6111[a]	2.6065[a]
Overrun %	37.37[a]	39.69[a]	44.95[a]	46.51[a]	48.27[a]
Freezing time(min)	19.4[e]	18.6[d]	15.1[c]	13.6[b]	12.7[a]
Melting % after:					
10 min	13.85	11.34	10.46	9.50	8.24
20 min	31.78	29.48	27.32	23.52	19.70
30 min	43.68	42.02	39.40	37.82	31.01
40 min	71.73	68.22	65.46	61.78	51.33
50 min	94.91	92.63	77.95	73.69	70.44
60 min	100	100	84.38	78.77	75.68
80 min	-	-	100	87.92	80.27
100 min	-	-	-	100	100

See details in Table 2.

TABLE 8. Organoleptic score of resultant ice milk which fortified by germinated garden seeds paste and Ultrasonic technique.

Property	Treatments				
	C_1	C_2	T_1	T_2	T_3
Flavor (50)	50[a]	50[a]	50[a]	50[a]	40[b]
Body &texture (30)	23[a]	28[b]	30[ab]	30[ab]	30[a]
Melting rate (10)	7[a]	9[a]	10[a]	10[a]	8[a]
Color (10)	10[a]	10[a]	10[a]	10[a]	8[a]
Total score (100)	90[b]	97[a]	100[a]	100[a]	86[c]

See details in Table 2.

Conclusion

It could be recommend the use of ultrasonic technique without pasteurization or homogenization in ice milk mixtures to improve the sensory, rheological, and functional properties and preserve vitamins, especially vitamin C. It also worked to increase the antioxidants and the sense of creaminess of the product. We also recommend the use of germinated garden cress seed paste (GCSPc) at a 10% replacement rate without adding stabilizer/emulsifier, which improves texture, composition, and rheological, physicochemical, properties. Also, GCSP raises the nutritional value of minerals, vitamins, and antioxidants in the end product.

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تأثير التدعيم بمعجون بذور مستنبت حب الرشاد و استخدام تقنية الموجات فوق الصوتية على خصائص اللبن المثلج

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تأثير إضافة عجينة مستنبت بذور حب الرشاد (Gcsp) باستخدام تقنية الموجات فوق الصوتية على الخصائص الفيزيائية والكيميائية والريولوجية والحسية للمثلج اللبنى. علاوة على ذلك ، حيث تمت دراسة مضادات الأكسدة والمركبات الفينولية والمعادن والفيتامينات الموجودة في مخاليط المثلج اللبنى والمنتجات المجمدة الناتجة عنها. فقد تم إضافة GCSP (البديل الجزئي لخليط المثلج اللبنى) بمستويات ٥ و ١٠ و ١٥٪ إلى مخاليط المعاملات التجريبية دون إضافة مثبت / مستحلب واستخدام تقنيات الموجات فوق الصوتية بدون بسترة ، بينما احتوت معاملتى الكنترول على ٤٪ دهن ، ١٥ ٪ سكر ، ١٢٪ جوامد صلبة لادهنية ، و ٠,٣٥٪ مواد رابطة. حيث كان أحد المعاملات لمخلوط الكنترول هواجراء عليه عملية البسترة (C_1)، بينما تم إجراءالكنترول الاخر (C_2) بتقنية الموجات فوق الصوتية وبدون بسترة.

أشارت النتائج إلى زيادة معنوية في المادة الجافة والرماد والبروتين الكلي والألياف والكربوهيدرات في مخاليط Gcsp بزيادة مستويات الإضافة. بينما لم توجد فروق ذات دلالة إحصائية في محتويات قيمة الأس الهيدروجيني والدهون والحموضة بين معاملات Gcsp. كما أظهرت البيانات وجود فروق معنوية بين معاملتى الكنترول ومعاملات Gcsp الأخرى في محتويات المعادن (Fe، P، K، Ca، Mg، Zn، Mn) والفيتامينات (C، E، A، K وحمض الفوليك). بينما احتوت معاملتى الكنترول على أقل قيم فى مضادات الأكسدة والمركبات الفينولية. وقد تم قبول جميع المعاملات فى التحكيم الحسى باستثناء المعاملة المحتوية على 15٪ Gcsp في النكهة. وقد وجد ان المثلج اللبنى والمضاف اليه Gcsp حتى 10٪ وبدون إضافة مواد رابطة وباستخدام تقنية الموجات فوق الصوتية حصل على خصائص حسية أعلى مقارنة بمعاملتى الكنترول.

لذا كانت التوصية بأنه يمكن إنتاج مثلج لبنى ذو جودة عالية تفوق الكنترول اذا أضيف له حتى 10٪ من مستنبت بذور حب الرشاد وبتقنية الموجات فوق الصوتية ، وبدون إضافة أى مواد رابطة.