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THE EFFECT OF CRESS SEED GUM & LOCUST BEAN GUM ON TEXTURAL PROPERTIES OF LOW FAT SET YOGURT

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ABSTRACT

Removing fat causes some structural and textural defects such as syneresis. The structural & physical properties of low fat set yogurt may be improved by using natural hydrocolloids such as cress seed gum & locust bean gum as fat replacers. The effects of these hydrocolloids, due to the higher consistency index values of Lepidium sativum seed extract at pH 4, & the higher viscosity index values of locust bean gum solutions at pH 4.2, on low fat set yogurt were evaluated. The results showed that there were significant differences ($P<0.05$) between the means of three time periods, i.e.: 1^{st}, 7^{th} and 14^{th} days after cooling, as observed in pH, acidity, hardness & viscosity index.

KEYWORDS: Lepidium Sativum Seed Extract, Locust Bean Gum, Low Fat Set Yogurt, Textural Properties

Yogurt is more nutritious than milk because of the presence of live probiotics and conversion of lactose into lactic acid. Microbial action on the milk base and the resulting changes in acidity also make the fermented dairy products like yogurt more stable than milk (Van De Water, Keen, & Gershwin, 1999).It has been recognized that an increase in dietary fat, especially animal fat, might increase the risk of cardiovascular disease. Since animal fats, including milk fat, can increase cholesterol, the demand for the consumption of low-fat products has been growing, but given the amount of total solids in milk, it can affect physical and textural properties of yogurt. So the texture generated from these compounds is weak and thus, the syneresis running high. For this reason, many studies have been done to improve physicochemical and rheological properties of low-fat and non-fat yogurt, with a wide variety of additives (Baig, Mirza, & Prasad, 1996). Among these additives, hydrocolloids have a high molecular weight and are hydrophilic molecules. They are used as a functional ingredients in food formulation for increasing food consistency, improving gelling effect, and controlling the microstructure, texture, flavor &shelf lifeThe use of hydrocolloids has been greatly expandes in recent years. Though most hydrocolloid concentrations are less than 1%, a trace amount of them affects the textural properties and mouth feel characteristics of products. Multiple functional properties of hydrocolloids make it possible to use them extensively. These features include varying degrees of adhesiveness to flow ability, i.e. viscosity and increasing consistency. The second main feature of the gums is their ability to form gels; unlike the first feature, this is seen only in a few (Razavi, Farhoosh, &Bostan, 2007).

Gum seeds

It has been indicated that galactomannan families play the most prominent role. Mixtures of hydrocolloids are commonly used to impart novel and improved rheological characteristics to food products. Classic examples include the addition of locust bean gum to *kappa* carrageenan to yield softer more transparent gels and also, the addition of locust bean gum to xanthan gum to induce gel formation. The nature of the synergy can be due to the association of different hydrocolloid molecules or non-association. (Phillips & Williams, 2000).

Gummy System

Gum solutions with a high value of "n" (flow behavior index) tend to feel slimy in the mouth. When less slimy mouth feel characteristics are desired, the choice should be a gum system with a low "n" value. Therefore, the Lepidium sativum seed extract is suitable for applications that require less slimy texture or mouth feel, such as a possible thickener in the treatment of dysphagia **(**Karazhiyan, 2009).These researchers have reported that the consistency index was increased with increasing concentration. The effect of temperature on viscosity changes was reversible; these changes were caused by molecular interactions that were low at the high temperature (Garcia-Ochoa, Casas, 1992). Viscosity was increased with increasing the concentration of Lepidium sativum seed extract. Increased viscosity can be attributed to increase concentration of soluble solids content. This phenomenon leads to the reduction of molecular motion, the formation of films inside the network, and the increase of viscosity (Maskan&Gogus, 2000).Foods are often

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subjected to thermal treatments that are effective on the functional characteristics of hydrocolloid solutions. When the hydrocolloid solutions are heated, there is a reversible increase in Lepidium sativum seed extract viscosity (Najitabasi, Razavi, & Karazhiyan, 2012).

Synergistic Effect

Galactomannans (such as locust bean gum) are compatible with most special hydrocolloids. There is a beneficial synergistic increase in viscosity and / or gel strength by mixing the galactomannan gums with particular linear polysaccharides, such as xanthan, yellow mustard mucilage, k - Carrageenan and agarose (CUI, 2005). Due to the structural and rheological similarity of Lepidium sativum seed extract and xanthan (Karazhiyan, 2009), In this paper, we are going to investigate the synergistic effect of Lepidium sativum seed extract & locust bean gum on low fat set yogurt.

MATERIALS AND METHODS

Preparation of Lepidium sativum seed extract

Cress seed gum isolation

0.1M-NaOH was used to give pH10 to the distilled water. Water bath (Fater Rizpardaz Iran) was used to raise the internal temperature to 35℃.The ratio of cress seeds to the distilled water was 30:1.The mixture needed to be stirred for 15 minutes; then a juice extractor was used to isolate its extract. A vacuum filter was used too. The temperature of oven set at 60℃ to dry the mass for about 12-24h. The dry masses were collected, and then powdered by pestle (Karazhyian & Razavi, 2013).

Preparation of starter

The temperature of skim milk was raised to 90℃and kept for half an hour; after that, the starter was added. The mix was cooled to 47℃, and larger amounts (20000mg/l) of it were added to milk.

Preparation of yogurt containing hydrocolloid

To produce the yogurt containing hydrocolloid, the desired amounts of Lepidium sativum seed extract & locust bean gum were added to low fat milk according to what comes below:

- S2L0
  The concentration of cress seed gum in low fat milk was 200mg/l
- S1L1
  Containing 100mg cress seed gum and 100mg locust bean gum per liter of milk
- S0l2
  The concentration of locust bean gum in low fat milk was 200mg/l
- S0l0
  It had no hydrocolloid, and was specified as a blank (control yogurt).

Finally, skim milk was used to standardize the total solid content to 12%; then all the samples were mixed, as long as its content was entirely consistent. Milk was heated at 85℃ for 5min to pasteurize (Ünal, Metin, & Develi, 2003), and then rapidly cooled; while the temperature was 45 ° C, starter culture was inoculated. Specimens reaching up to 80 °D were incubated at 42°C and then rapidly cooled to 5 °C and kept at the same temperature.

pH analysis

pH value of samples was measured using pH-meter (Knick, 766 calorimetric) at 20℃

Acidity analysis

Acidity was measured based on Dornic degree according to AOAC. (2002), Official methods of analysis of the AOAC, 15th ed. (Ed. S. Williams).

Water Holding Capacity analysis

As described by Parnell-Clunies et al. (1986) Yogurt samples (2g) in sigma Aldrich microcentrifuge tubes were centrifuged at13500g for 30min at 10℃(Sigma Zentrifugen GmbH) . Water Holding Capacity was expressed as the percentage of pellet weight relative to the original weight of the sample. Determination was carried out in triplicate.

Texture analysis

TPA test acts according to BROOKFIELD CT3 TEXTURE ANALYZER device Brochures,which is related to low-fat yogurt, according to the following:

PROBE REF: TA4 38.1mm, Perspex Cylinder, Samples were removed under refrigerated conditions of 5°C and centrally positioned beneath the probe within the container in which they were packed. Tests were conducted at ambient 18.2°C. Parameters for studying are listed below. Determinations were done in duplicate.

HARDNESS: Force necessary to attain a given deformation (expressed as g)

Work (Total Positive Area): Internal strength of bonds within a product (expressed as milli-joule)

ADHESIVENESS (Total Negative Area): Work necessary to overcome attractive forces between the surface of the food and the materials with which it comes into contact (expressed as milli-joule).

Statistical analysis

Statistical analysis was performed through subjection of data to analysis of variance (ANOVA) using SPSS statistical software (ver- sion 19.0; SPSS, Inc., Chicago, IL). Means were subjected to Dun- can's test and P value < 0.05 was considered statistically significant.

RESULTS & DISCUSSION

pH

The effect of different hydrocolloids and storage periods on the pH value of set yogurt is shown in table1.The pH of the milk is one of the major factors determining the development of its network, resulting in viscoelastic properties of yogurt (Lee &Lucey, 2004). Types of microbes, the rate of incubation, and the incubation temperature largely affect the rate of acidification and the eventual gel strength of the yogurt. One-week storage at 4°C resulted in a slight increase in the compression force of yogurts, because of the continued reduction in pH (Oliveira, Sodini, Remeuf, &Corrieu, 2001). In young gels (shortly after formation),the elastic or storage modulus (G') is low and the pH is still at high levels, where the electrostatic attraction between casein particles is not yet as high as it would be in aged gels (Sendra et al.,2010).pH treatments after one day cooling showed a significant difference (P<0.05). This means that such kinds of yogurt were treated by locust bean gum (S0L2) with the lowest pH, but blank (S0L0) was devoted to the highest. On the 7th day, the lowest pH was related to S1L1 (yogurt stabilized by locust bean gum & cress seed gum) &S0L2 (yogurt stabilized by locust bean gum), while on the 14th day, there was no significance difference between the treatments.

Table 1: pH changes during cooling (1st day, 7th day and 14th day)

Treatment	Cooling days			Mean
	pH1	pH7	pH14	
S0L0	$4.44±0.11^{A**}_{a*}$	$4.29±0.12^{B}_{ab}$	$4.27±0.12^{B}_{a}$	$4.33±0.14_{a}$
S2L0	$4.38±0.07^{A}_{ab}$	$4.33±0.16^{A}_{a}$	$4.25±0.09^{B}_{a}$	$4.32±0.08_{a}$
S1L1	$4.36±0.13^{A}_{ab}$	$4.23±0.07^{B}_{bc}$	$4.22±0.10^{B}_{a}$	$4.27±0.12_{ab}$
S0L2	$4.30±0.10^{A}_{b}$	$4.21±0.07^{B}_{c}$	$4.19±0.03^{B}_{a}$	$4.23±0.09_{b}$

S0L0: control yogurt
S2L0: yogurt stabilized by cress seed gum
S1L1: yogurt stabilized by cress seed gum & locust bean gum
S0L2: yogurt stabilized by locust bean gum
*a-c means within the same column with different subscriptions are significantly different (P<0.05)
**A-B means within the same row with different subscriptions are significantly different (P<0.05)
results: mean ± sd

Acidity

The effect of different hydrocolloids and storage periods on the acidity value of set yogurt is shown in table2. In industrial dairy processing, the acidification method is widely used. During the production of yogurt, or similar products, the pH of milk is decreased from about 6.7 to 4-4.5. Hereby, the carboxylic groups along the polyelectrolyte chain are neutralized (Chen, Dickinson, & Edwards, 1999). Generally, within each stabilizer treatment, Titrable Acidity is increased significantly with the increase in storage period. Titrable Acidity was significantly higher (P<0.05) for samples stored for 14 days than that at the beginning of storage period. When storage period was disregarded, the control yogurt (no stabilizer added) had a significantly lower Titrable Acidity value.

Table 2: Acidity changes during cooling (1st day, 7th day and 14th days)

Treatment	Cooling days			Mean
	acidity1	acidity7	acidity14	
S0L0	76.95^{A**}_{a*}	84.12^{AB}_{a}	85.94^{B}_{a}	82.34_{a}
S2L0	82.95^{A}_{b}	88.56^{B}_{ab}	90.87^{B}_{ab}	87.62_{b}
S1L1	89.72^{A}_{c}	96.68^{A}_{bc}	97.54^{A}_{b}	94.65_{c}
S0L2	89.09^{A}_{c}	97.57^{B}_{c}	100.30^{B}_{b}	95.66_{c}

S0L0: control yogurt
S2L0: yogurt stabilized by cress seed gum
S1L1: yogurt stabilized by cress seed gum & locust bean gum
S0L2: yogurt stabilized by locust bean gum
*a-c means within the same column with different subscriptions are significantly different (P<0.05)
**A-B means within the same row with different subscriptions are significantly different (P<0.05)

Water Holding Capacity

The effect of different hydrocolloids and storage periods on the Water Holding Capacity value of set yogurt is shown in table3. Water Holding Capacity measures the amount of water absorbed in the protein structure in yogurt. Increased micelle size and increased whey-casein and casein-casein interactions lead to a more porous gel, which could retain more water (Parnell-Clunies, Kakuda, Mullen, Arnot, DeMan, 1986). Lactic acid bacteria fermentation resulted in increased acidity and casein aggregation. Larger particles precipitated, causing lower water-holding capacity as well as more marked whey separation (Zhang & Yan, 2012).According to Table 3, no significant differences ($P < 0.05$) were observed, except for the first day after cooling.

Table 3: Water holding capacity changes during cooling (1st day, 7th day and 14th days)

Treatment	Cooling days			Mean
	whc1	whc7	whc14	
S0L0	$26.13\pm1.19^{A**}_{a*}$	$18.87\pm1.88^{B}_{a}$	$22.80\pm1.30^{C}_{a}$	$22.10\pm1.45_{a}$
S2L0	$29.24\pm1.23^{A}_{ab}$	$20.68\pm1.75^{B}_{a}$	$24.38\pm1.61^{B}_{a}$	$24.13\pm1.53_{a}$
S1L1	$30.64\pm1.35^{A}_{b}$	$19.35\pm1.40^{B}_{a}$	$25.06\pm1.92^{C}_{a}$	$24.22\pm1.55_{a}$
S0L2	$30.21\pm1.19^{A}_{b}$	$20.31\pm1.17^{B}_{a}$	$25.28\pm1.42^{C}_{a}$	$24.56\pm1.26_{a}$

S0L0: control yogurt
S2L0: yogurt stabilized by cress seed gum
S1L1: yogurt stabilized by cress seed gum & locust bean gum
S0L2: yogurt stabilized by locust bean gum
*a-c means within the same column with different subscriptions are significantly different (P<0.05)
**A-C means within the same row with different subscriptions are significantly different (P<0.05)
results: mean ± sd

Textural Properties

Hydrocolloids can also increase the firmness and viscosity of yogurt by binding water (restricting its movement) and interacting with milk proteins to stabilize the protein network (Tamime, & Robinson, 1999).

Hardness

The effect of different hydrocolloids and storage periods on the Hardness value of low fat set yogurt is shown in table4. The hardness of the four types of low fat yogurt gels was measured after days1, 7&14 and manufacturing. As can be seen from table 4, the only significant difference (P<0.05) was observed on the first day after cooling storage. If the storage period were ignored, in this case, this would be a significant difference between the treatments and the highest hardness would be allocated to S1L1 & S0L2.

Table 4: Hardness changes during cooling (1st day, 7th day and 14th day)

Treatment	Cooling days			Mean
	hardness1	hardness7	hardness14	
S0L0	64.87^{A**}_{a*}	91.75^{A}_{a}	110.50^{B}_{a}	89.09_{a}
S2L0	81.00^{A}_{ab}	98.75^{AB}_{a}	112.25^{B}_{a}	97.33_{a}
S1L1	102.00^{A}_{ab}	124.50^{A}_{a}	133.12^{A}_{a}	119.87_{b}
S0L2	104.12^{A}_{b}	119.12^{A}_{a}	147.37^{A}_{a}	123.87_{b}

S0L0: control yogurt
S2L0: yogurt stabilized by cress seed gum
S1L1: yogurt stabilized by cress seed gum & locust bean gum
S0L2: yogurt stabilized by locust bean gum
*a-c means within the same column with different subscriptions are significantly different (P<0.05)
**A-B means within row with different subscriptions are significantly different (P<0.05)

Adhesiveness

The effects of different hydrocolloids and storage periods on the viscosity index (Adhesiveness) value of low fat set yogurt are shown in table5.It can be concluded from Table5that significant differences (P<0.05) were observed on the first and seventh days, but there was no significant difference (P<0.05) on the fourteenth day. However, in all three time periods, S0L2 had the highest viscosity index; this is because of the segregative phase separation. In this type of phase separation, the interactions between the biopolymers are repulsive in nature and therefore, the system forms two separate phases, each of which is enriched with one biopolymer (Doublier, Garnier, , Renard, , & Sanchez, 2000). Segregative phase separation generally arises in conditions where the protein is in the presence of a neutral polysaccharide or an anionic polysaccharide bearing a charge of the same sign as the protein. Obviously, the main parameters involved in this mechanism are pH and ionic strength (Bourriot, Garnier, &Doublier, 1999).

Table 5: Adhesiveness changes during cooling (1st day, 7th day and14th day)

Treatment	Cooling days			Mean
	adhesiveness1	adhesiveness7	adhesiveness14	
S0L0	0.39^{A**}_{a*}	0.58^{A}_{a}	1.51^{A}_{a}	0.83_{a}
S2L0	0.93^{A}_{ab}	2.07^{A}_{ab}	2.63^{A}_{a}	1.93_{ab}
S1L1	1.90^{A}_{ab}	3.30^{A}_{b}	2.79^{A}_{a}	2.70_{b}
S0L2	2.80^{A}_{b}	3.31^{A}_{b}	3.89^{A}_{a}	2.92_{b}

S0L0: control yogurt
S2L0: yogurt stabilized by cress seed gum
S1L1: yogurt stabilized by cress seed gum & locust bean gum
S0L2: yogurt stabilized by locust bean gum
*a-c means within the same column with different subscriptions are significantly different (P<0.05)
**A-B means within the same row with different subscriptions are significantly different (P<0.05)

CONCLUSION

Gel texture of fermented milk such as yogurt is generally considered more important than other sensory characteristics, because its desirable texture improves the perception of flavor and taste features. The ratios of hydrocolloids applied in this work made significant changes in almost all properties of low fat set yogurt. People's tastes should be understood and products must be made with different textural and physicochemical characteristics. This requires the knowledge of the characteristics of yogurt& the hydrocolloids added as the stabilizer. However, plant gums such as cress seed gum have two notable advantages, either as functional components or thickeners, but because of their low concentration, they may not satisfy the consumer requirement. So a kind of hydrocolloid can be used that has a synergistic effect on it, but they almost must have the same properties, such as pH limitation.

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