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Seed gum of basil (*Ocimum basilicum* L.) as a halal hydrocolloid affects technological and organoleptic properties of probiotic low-fat yogurt

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Abstract

Background and objective: *Ocimum basilicum*, generally identified as sugary basil, is a popular culinary herb. It contains functional oils such as chavicol, linalool, and eugenol, which are usually used in food and pharmaceutical industries. The aim of this study was evaluating the effect of basil seed gum on physicochemical and sensory attributes of low-fat probiotic yogurt.

Materials and methods: Effect of basil seed gum at concentrations of 0.1 and 0.2% w/w was studied in low fat probiotic yogurt during 1, 7, and 15 days. pH, acidity, viscosity, and dry matter were analyzed in the samples and compared to control. Sensory properties were included to color, texture, mouthfeel, and flavor.

Results and conclusion: After addition of basil seed gum to the yogurts, pH of the samples was slightly lower than control. By increasing the concentration of gum, viscosity and dry matter were increased during storage. Analysis of sensory evaluation showed that the samples containing gum had significant differences in texture compared to control. Sensory properties were improved by addition of gum except for color which had the best score in control. The samples containing 0.1% w/w gum had significantly better flavor in comparison to the samples containing 0.2% w/w gum in which the best mouthfeel was found. The least score of mouthfeel was related to control, although the differences were not significant. Results showed that basil seed hydrocolloid has good potential to be used as fat replacer in food formula such as yogurt.

Keywords: Basil seeds, Hydrocolloid, *Lactobacillus acidophilus*, *Lactobacillus casei*, Low-fat yogurt

1. Introduction

By increasing the obesity in societies, food industries have provided low-calorie products to the market. According to Codex, energy reduction in reduced-calorie foods should be over 25% compared to high-fat foods. For example, low-fat dairy products containing fat between 0.5 and 1.5% are interested to reduce calorie intake and prevent different diseases [1,2]. Fatty foods are strongly associated with cardiovascular disease. Therefore, fat reduction in foods is recommended by the health agencies to decrease the rate of non-

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communicable diseases. By increasing the rate of cardiovascular diseases in the last decade, low-fat foods especially dairy products are requested by the consumers and consumption of low-fat/non-fat dairies is increasing globally [3].

Various studies have been done about use of fat replacers in low-fat dairy products. Considering the role of fat in development of texture, taste, and smell in foods, its replacers should provide such affects in the media so that do not disturb palatability of the product. Gums are hydro-colloid which increase viscosity of the environment by absorption of around water [4]. They are extracted from different sources including alga, microorganisms, and plants. They consist of hydrophilic molecules which binds water to form viscous solutions or gels [5]. The gums are added to foods as thickener, gelling agent, stabilizer, fat replacer, and edible film. Yogurt is one of the most popular dairy products in the world. Different types of yogurt are produced such as low-fat yogurt, probiotic yogurt, frozen yogurt, and soft drink yogurt [6]. It is a good candidate for fat replacement by various hydrocolloids. For example, Aziznia et al. investigated the effect of tragacanth gum and whey protein concentrate on improving the physicochemical and sensory properties of fat-free yogurt. Accordingly, addition of whey protein concentrate decreased the syneresis, while tragacanth had no effect on wetting up to 0.5% w/w [3].

Tendency to the probiotic-containing foods is growing around the world that is due to the increasing awareness about their health-promoting effects. Most of probiotic strains belong to the genera Bifidobacterium and Lactobacillus [1,5]. Addition of probiotic to yogurt is one of possible ways to achieve the functional ingredients through edible route [2]. Probiotics have numerous positive effects including protection against harmful microorganisms, strengthening the immune system, attenuation of infection, lowering blood pressure, anticancer, antioxidant, reducing the symptoms of dermatitis and allergies, facilitating the mineral absorption, protection against ulcerative colitis and clone disease, prevention of osteoporosis and arthritis, prevention of dental caries, prevention of obesity and adjustment of energy expenditure and fat metabolism [7]. Allen et al. in 2004 found that probiotics are effective as adjunctive therapy for treatment of infectious diarrhea and can be used together with oral rehydration [8].

Basil (*Ocimum bacilicum* L.) seed, a good source of dietary fiber, is black in color and has oval form [9]. *Ocimum basilicum* L. is a native plant of India and Iran and can be grown in tropical regions of Africa, and Central and South America. The plant contains essential oil, linalool, and Methyl chavicol with aromatic characteristic [10]. With regard to the impact of plant polysaccharides on quality of dairy products, we used basil seed gum as hydrocolloid for replacement of fat in probiotic yogurt. Therefore, its effect on qualitative parameters and sensory properties of probiotic low-fat yogurt was investigated.

2. Materials and methods

2.1. Materials

Skim milk were prepared from Kimia Iran company (Iran) and Basil seed was purchased from local shop (Tehran, Iran). *Lactobacillus acidophilus* ATCC 314 and *Lactobacillus casei* ATCC 374 were purchased from Iranian Research Organization for Science and Technology (IROST).

2.2. Basil seed gum extract

At first, basil seeds were cleaned. Extraction was done under soaking at 70 °C, pH=7 for 20 min with seed/water ratio of 1:65 [11]. Then, the seeds were poured in a mixer and mixed under low speed for one minute to separate mucilage from the seeds. The mixture was further centrifuged at 15,000 rpm for 10 min. Separation of gum from the seeds was done by a juicer (Pars Khazar, Tehran, Iran, 700P). The gum stunk to the seeds was separated by immersing the seeds in water and passing through the extractor. All the separated gums were passed through a cloth with small pores to fine particles were achieved. Finally, the gum was dried at 55 °C and powdered by a grinder.

2.3. Preparation of yogurt samples

Initially, skim milk (pH = 6.6, acidity 14 °D) was prepared. To adjust the milk fat on 1.5%, its dry matter was adopted with the skim milk powder (evaporation of the milk and removal of 10-20% water) [12]. Low-fat probiotic yogurts were further prepared by addition of probiotic bacteria to the milk at concentration of 10^8 CFU/ml and incubation at 44 °C up to achieve acidity of 95°D. For preparation of treatments, the gum at concentration of 0.1% and 0.2% were added to the yogurts (Table 1).

Table 1- Low-fat probiotic yogurts

Sample	Characteristics
CA	Low-fat yogurt, without gum, inoculated with *Lactobacillus acidophilus*
$BA_{0.1}$	Low-fat yogurt, containing 0.1% w/w basil seed gum, inoculated with *Lactobacillus acidophilus*
$BA_{0.2}$	Low-fat yogurt, containing 0.2% w/w basil seed gum, inoculated with *Lactobacillus acidophilus*
CC	Low-fat yogurt, without gum, inoculated with *Lactobacillus casei*
$BC_{0.1}$	Low-fat yogurt, containing 0.1% w/w basil seed gum, inoculated with *Lactobacillus casei*
$BC_{0.2}$	Low-fat yogurt, containing 0.2% w/w basil seed gum, inoculated with *Lactobacillus casei*

*C: control; A: *Lactobacillus acidophilus*; B: Basil; C: *Lactobacillus casei*

2.4. Biochemical Parameters

pH of the samples was determined according to the Iranian National Standard no. 2852 by Metrohm 691 pH-meter (Switzerland) [13]. Viscosity was measured using Brookfield viscometer (RVDV-I model, USA). Spindle no. 6 by speed of 70 rpm was used and all the samples were analyzed at 5 °C [14]. For determination of dry matter, 5-10 g of the yogurts were transferred to oven and left for 18-24 h at 90 °C. Then, the weight loss (moisture) was calculated and inserted in Eq. 1 to achieve the mass of dry matter [14].

Dry mass (%) = 100 – moisture Eq. 1

2.5. Sensory evaluation

Ten trained panelists were recruited to evaluate the samples in term of mouthfeel, texture, color, and flavor by 5-points hedonic method. The highest score of 5 indicated that the sample was "excellent" and the least score of 1 indicated that the sample was "very bad" [15].

2.6. Statistical analysis

The results were analyzed by SPSS software version 16. The means were compared by analysis of variance (ANOVA) at significance level of 0.05. The experiments were done in triplicate.

3. Results and discussion

3.1. Changes in pH, viscosity, and dry matter during storage

According to Table 2, pH of the samples was between 4.2 and 4.5 with a decreasing trend during storage, which was related to bacterial metabolism resulted in acid production. Our results were not consistent with findings of Amiri Aghdaei et al. [16], in which no significant effect of fleawort seed hydrocolloid on pH of low-fat yogurt was observed. Inclusion of dietary fiber in our products motivated the bacterial growth during time. Therefore, as a result of nutrients consumption by the starters in the environment followed by acid production, pH decreased [17-19].

Table 2- Changes in qualitative parameters of low-fat probiotic yogurts during storage

Sample	Time (day)	pH	Viscosity (cp)	Dry matter (%)
CA	1	4.46 ±0.05^{aA}	1616.66 ±28.86^{aA}	8.67 ±0.05^{cA}
	7	4.43 ±0.11^{aA}	1736.66 ±32.14^{aA}	8.83 ±0.28^{cA}
	15	4.25 ±0.13^{aB}	1870.00 ±75.14^{aA}	9.70 ±0.26^{cA}
$BA_{0.1}$	1	4.43 ±0.11^{aA}	1750.00 ±50.00^{bA}	9.80 ±1.31^{aA}
	7	4.43 ±0.15^{aA}	1873.33 ±30.55^{bB}	11.16 ±2.36^{aB}
	15	4.22 ±0.07^{aB}	1966.66 ±30.55^{bC}	13.66 ±0.57^{aC}
$BA_{0.2}$	1	4.50 ±0.50^{aA}	1850.00 ±86.60^{cA}	13.33 ±0.57^{bA}
	7	4.41 ±0.37^{aA}	2080.00 ±62.44^{cB}	14.20 ±0.98^{bB}
	15	4.26 ±0.23^{aB}	2288.33 ±76.86^{cC}	15.66 ±0.57^{bC}
CC	1	4.45 ±0.05^{aA}	1650.00 ±50.00^{aA}	8.70 ±0.26^{cA}
	7	4.43 ±0.51^{aA}	1753.33 ±105.33^{aA}	9.66 ±0.28^{cA}
	15	4.25 ±0.25^{aB}	1816.66 ±12.83^{aA}	9.66 ±0.28^{cA}
$BC_{0.1}$	1	4.50 ±0.49^{aA}	1776.66 ±25.16^{bA}	10.53 ±0.40^{aA}
	7	4.39 ±0.19^{aA}	1876.66 ±25.16^{bB}	12.50 ±050^{aB}
	15	4.20 ±0.09^{aB}	1960.00 ±52.9^{bC}	13.53 ±0.50^{aC}
$BC_{0.2}$	1	4.45 ±0.49^{aA}	1866.66 ±30.55^{cA}	13.00 ±1.00^{bA}
	7	4.43 ±0.11^{aA}	2100.00 ±100.00^{cB}	14.50 ±0.50^{bB}
	15	4.24 ±0.08^{aB}	2165.00 ±172.98^{cC}	15.66 ±0.28^{bC}

*C: control; A: *Lactobacillus acidophilus*; B: Basil; C: *Lactobacillus casei*
Different small letters show significant differences in rows.
Different capital letters show significant differences in column

Results of the current study indicated that viscosity of the samples improved by addition of gum (Table 2). Significant differences were observed in viscosity between the samples containing 0.1% w/w and 0.2% w/w gum. This finding was consistent with those reported in other studies [18-20]. The least and highest viscosities were related to control in first day of storage and the sample containing *L. acidophilus* and 0.2% w/w gum in day 15, respectively.

Significant change in dry matter was observed between the samples containing 0.2% w/w gum compared to 0.1% w/w gum within 15 days. Storage time significantly affected the dry matter in the samples containing gum, while no significant change was observed in dry matter of control during storage. The increase in dry matter of yogurts was related to the gum and stimulated growth of probiotic bacteria [17]. Sahebkhani et al. produced probiotic fruit yogurt containing strawberry pulp by ewe milk. They showed that storage time had significant impact on dry matter of the samples [21].

3.2. Sensory attributes during storage

Sensory properties play critical role in consumers' satisfaction. Sensory evaluation showed that the samples containing gum had significant differences with control in texture. Firmness of yogurts containing gum was more than control; although there was no significant difference in firmness between the samples containing 0.1% and 0.2% w/w gum (Table 3). In contrast, control had the most score of color. The samples containing 0.1% w/w gum had more flavor score compared to the samples containing 0.2% w/w gum. Storage time improved the flavor significantly. Hosseini et al. investigated the effect of maltodextrin and xanthan gum on physicochemical, sensory, and microbial properties of fat-free probiotic yoghurt containing *L. paracasei* subsp. *Paracasei*. They showed that there was no significant difference in color of the samples during storage, while the samples containing xanthan had a higher score of color compared to maltodextrin [22]. The most score of mouthfeel was found in the sample containing 0.2% w/w gum and the least score was observed in control; although the difference was not significant. In addition, mouthfeel of the samples improved significantly over time. Razmkhah Sharabiani et al. evaluated the effect of pectin, sage, and basil seeds on physicochemical and sensory properties of low-fat yogurt. The highest and least scores of mouthfeel were related to the samples containing 0.05% and 0.2% w/w gum, respectively. In comparison, the highest sensory score was observed in nonfat concentrated yogurt containing 0.5% w/w sage gum. The samples containing pectin had the highest dry matter and firmness. In agreement, storage improved the sensory properties of non-fat yogurts [23].

Table 3- Sensory attributes of low-fat probiotic yogurts during storage

Sample	Time (day)	Texture	Flavor	Color	Mouthfeel
CA	1	3.16 ±0.28 ^{bC}	3.66 ±0.28 ^{aB}	4.66 ±0.28 ^{aA}	3.33 ±0.28 ^{bB}
	7	3.66 ±0.28 ^{abB}	4.33 ±0.00 ^{aA}	4.33 ±0.57 ^{aA}	3.66 ±1.40 ^{abAB}
	15	4.33 ±0.28 ^{aA}	4.66 ±0.50 ^{aA}	4.16 ±0.60 ^{aA}	4.33 ±0.28 ^{aA}
$BA_{0.1}$	1	4.16 ±0.28 ^{aAB}	4.33 ±0.42 ^{aA}	4.16 ±0.28 ^{aA}	4.17 ±0.14 ^{aA}
	7	4.16 ±0.28 ^{aAB}	4.50 ±0.11 ^{aA}	4.00 ±0.00 ^{aA}	4.33 ±0.86 ^{aA}
	15	4.66 ±0.57 ^{aA}	4.66 ±0.28 ^{aA}	4.00 ±0.50 ^{aA}	4.16 ±0.76 ^{aA}
$BA_{0.2}$	1	4.33 ±0.28 ^{aA}	3.83 ±0.56 ^{aAB}	3.83 ±0.36 ^{aA}	4.50 ±0.20 ^{aA}
	7	4.50 ±0.28 ^{aA}	4.00 ±0.50 ^{aA}	3.83 ±0.28 ^{aA}	4.66 ±0.76 ^{aA}
	15	4.50 ±0.50 ^{aA}	4.33 ±0.28 ^{aA}	3.83 ± 0.76 ^{aA}	4.83 ±0.46 ^{aA}
CC	1	3.50 ±0.50 ^{abA}	4.16 ±0.86 ^{aA}	4.83 ±0.36 ^{aA}	3.33 ±0.76 ^{abB}
	7	3.83 ±0.28 ^{abA}	4.50 ±0.50 ^{aA}	4.33 ±0.57 ^{aA}	3.66 ±0.28 ^{bAB}
	15	4.00 ±0.50 ^{aA}	4.66 ±0.50 ^{aA}	4.33 ±0.76 ^{aA}	4.16 ±0.36 ^{aA}
$BC_{0.1}$	1	4.00 ±0.76 ^{aA}	4.16 ±0.16 ^{aB}	4.30 ±0.76 ^{aA}	4.00 ±0.50 ^{aB}
	7	4.33 ±0.50 ^{aA}	4.66 ±0.28 ^{aA}	3.83 ±0.28 ^{aA}	4.50 ±0.00 ^{aAB}
	15	4.50 ±1.25 ^{aA}	4.83 ±0.28 ^{aA}	3.83 ±0.36 ^{aA}	4.67 ±0.34 ^{aA}
$BC_{0.2}$	1	4.17 ±0.28 ^{aA}	3.83 ±1.25 ^{aA}	4.17 ±0.25 ^{aA}	4.33 ±0.28 ^{aA}
	7	4.50 ±0.28 ^{aA}	4.00 ±0.00 ^{aA}	3.66 ±1.25 ^{aA}	4.50 ±0.00 ^{aA}
	15	4.66 ±0.42 ^{aA}	4.00 ±0.50 ^{aA}	3.66 ±0.86 ^{aA}	4.66 ±0.80 ^{aA}

*C: control; A: *Lactobacillus acidophilus*; B: Basil; C: *Lactobacillus casei*
Different small letters show significant differences in rows.
Different capital letters show significant differences in column

Importantly, probiotics have significant role in development of sensory attributes in foods. For example, addition of *L. plantarum* to yogurt improved the taste and addition of coated bacteria with alginate and starch improved the color of yogurt in the study of Tamime and Robinson [24]. In general, our treatments showed good qualitative and sensory attributes compared to the control. However, it is recommended to evaluate viability of probiotic strains in the yogurt containing basil seed gum.

4. Conclusion

Use of basil seed gum as a fat replacer in yogurt had positive impact on qualitative parameters. Our treatments had appropriate viscosity and were well accepted by the sensory evaluators compared to control. Therefore, the hydrocolloid has good potential as a fat replacer in the formula as well as can retain the desired sensory properties of probiotic low-fat yogurt.

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6. Conflict of interest

The authors declare no conflict of interest.

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