



Conference Article

## Development of a Symbiotic Snacks Bar Product

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### Abstract

*In this study, control (not containing inulin and probiotic) prebiotic and symbiotic (including probiotic and prebiotic) bar formulations were developed using whey protein concentrate (WPC), oat flour, inulin, or Lactobacillus rhamnosus (L. rhamnosus) GG. The total solids and protein values of the products were varied from 86.90 to 89.21% and from 20.85 to 21.78%, respectively. The probiotic viable count in the symbiotic bar sample was 8.05 log cfu/g. Sensory analysis revealed that all samples exhibited similar visual characteristics, while the prebiotic bar received the highest taste and overall approval scores. The findings demonstrated that WPC and inulin were effective in preserving probiotic viability and product quality. In conclusion, the developed symbiotic bar formulation is considered an innovative product suitable for the healthy snack market, with both functional and nutritional properties.*

**Keywords:** Snacks Bar, Prebiotic, Probiotic, Symbiotic



## 1. Introduction

In parallel with the development of technology and the food industry, rising living standards and rising education levels in many countries are leading to increased consumer awareness. Conscious consumers are not only interested in the nutritional content of foods but also their positive health effects [1]. This consumer orientation has led to numerous scientific and clinical studies in recent years on the relationship between food consumption and human health, both scientifically and industrially. Among these studies, studies focusing on functional foods, which contain nutritional components that exert physiological effects beyond basic nutrition and affect the immune system, are of particular interest [2]. Furthermore, the use of grains in various food formulations and the development of grain-based foods for the development of functional foods have been the subject of much research in recent years [3]. For a food to be functional, it must contain factors such as bioactive compounds, probiotic microorganisms, and prebiotic substances, and these factors must be effective in the human body [4]. Probiotic bacteria are living microorganisms that, when consumed in sufficient amounts, confer benefits on the host; These support immune function, prevent the proliferation of pathogenic microorganisms, and can have positive effects on metabolic health, particularly by keeping the intestinal microbiota in balance [5]. *L. rhamnossus*, one of the probiotic bacteria, is a particularly prominent probiotic in clinical and industrial terms. The LGG strain of *L. rhamnossus* has acid and bile resistance and can survive in the intestine for long periods. It is used in many functional foods due to its beneficial effects [6]. In studies in the literature, when used in grain-based, processed products such as noodles and pasta, the *L. rhamnossus* GG strain maintained its viability at a level of  $\geq 10^6$  CFU/g after thermal treatment. This value corresponds to the viability threshold required for probiotic activity [7]. Prebiotics, another important ingredient, are non-digestible food ingredients with oligosaccharide and polysaccharide structures like inulin. They can positively impact host health by supporting the growth and selective activation of certain microorganisms within the microbiota, especially probiotics [4]. Inulin is an important prebiotic for probiotic bacteria, particularly supporting the growth and metabolic activity of Lactobacillus and Bifidobacterium species in the intestine. Its fermentable structure enhances the production of short-chain fatty acids, strengthening host immunity and intestinal barrier integrity. Furthermore, when added to functional foods, it increases the viability of probiotics, contributing to the preservation of their effectiveness throughout the product's shelf life [9].



Symbiotics, on the other hand, are the optimal combination of both probiotic and prebiotic ingredients in a single product. They were developed to maintain the viability of probiotics in the gastrointestinal tract, and symbiotic products maintain the viability of probiotic bacteria in the gastrointestinal tract more effectively than products containing only probiotics [10]. Today, increasing consumer awareness, parallel to technological advancements, is guiding individuals towards a healthy lifestyle and turning to easy-to-prepare and easy-to-consume functional foods. Research shows that protein-rich products hold approximately 30-40% market share in the "bar" market, a functional snack market [11].

Bars are nutrient-rich foods shaped like sticks, balls, or thin, long fingers. Depending on their composition and formula, these snack foods, which contain high levels of protein, fiber, carbohydrates, and other bioactive substances, in addition to macronutrients, are often used as space, military, sports, and emergency food. Milk and soy proteins, cereal fiber, and glucose syrups are the most used ingredients in these nutritional bars due to their balance between health benefits and cost-effectiveness [12].

As reported in the literature, the combined use of whey protein concentrate (WPC), inulin, and *L. rhamnosus* GG in snack production is considered an effective approach to develop products that are both nutritionally and functionally rich. With its high bioavailable protein content, WPC provides an environment that preserves the viability of probiotics while preserving the structural integrity of the food matrix. Indeed, the survival rate of *L. rhamnosus* GG during drying and storage has been reported to be significantly increased in WPC-coated systems. Furthermore, studies have shown that capsule matrices containing whey protein and inulin significantly increase probiotic stability in gastrointestinal conditions [13,14].

Combined, these findings suggest that the whey protein-inulin-probiotic combination is a suitable formulation to enhance symbiotic activity in cereal bars.

Considering today's consumer behaviour and market dynamics, two key trends in the snack bar segment complement each other. First, a fast-paced lifestyle and a growing awareness of sports and activities are driving a trend toward high-protein, portable, and convenient products. Second, growing awareness of gut health, the digestive system, and the microbiome is driving demand for functional foods containing prebiotics and probiotics (symbiotics). The global protein bar market, valued at approximately \$14 billion in 2023, is expected to reach approximately \$21 billion by 2030. Considering global product portfolios, the availability of bar formulas containing high protein (e.g., >20g), high fiber (e.g., >8-10g), plant-based ingredients, and symbiotics is relatively limited [15]. In this context, developing and marketing a new product with a "high-protein symbiotic bar" formula presents a strong market opportunity in terms of both demand and differentiation. In this study, it was aimed to produce a "healthy, functional, practical and



easily portable" bar by combining protein sources (WPC) containing high-fiber materials (oats) and symbiotic ingredients (prebiotic fibers + live probiotic cultures).

## 2. Materials and Methods

### 2.1. Materials

The study materials used were date molasses, oatmeal, walnuts, almonds, whey protein concentrate (WPC80), inulin, and *L. rhamnosus* as a probiotic source. The date molasses and oatmeal were obtained from a local market in Antalya; inulin was obtained from BMN Industrial Food Company; and WPC-80 from BEŞEL Industrial Products Food and Packaging Industry Trade Inc. *L. rhamnosus* GG Chr. Hansen, used as a probiotic, was obtained from Turkey.

### 2.2. Methods

In this study, three different snack bar formulations were prepared, including a probiotic and symbiotic control group containing no additives. The final product composition of the snack bars was designed to contain approximately 21% protein, 11% dietary fiber, 15% sugar, and 15% fat. All snack bar samples were prepared with oats, walnuts, almonds, date molasses for sweetening, and water. Inulin was added to the prebiotic snack bar products. Inulin and *L. rhamnosus* GG were added to the symbiotic bars. In the production of the control group and prebiotic snack bars, the dry ingredients were first mixed homogeneously. Simultaneously, the date molasses and water mixture was heated to 50°C and then added to the dry mixture to obtain a soft dough. Inulin was omitted from the control group formulation. The resulting dough was distributed in approximately 15-g portions into silicone molds and dried in a rotary tray dryer at 125°C for 15 minutes. Following the drying process, the products were kept in the oven until their core temperatures dropped to 90°C and then to 50°C, respectively.

In the production of probiotic snack bars, the dry and liquid ingredients in the formulation were mixed in the same way to form a dough and then inoculated with 0.1% *L. rhamnosus* GG culture. The dough was incubated at 25°C for 1 hour before fermentation. Fermentation was terminated when the pH reached 5.5. As in the other groups, the fermented dough was shaped into approximately 15 g portions in silicone molds and subjected to stepwise drying. Drying was carried out at 75°C for 10 minutes and 60°C for 25 minutes, respectively. After drying, the oven door was opened to allow the products to cool slowly and wait until the core temperature reached 30°C. The images of all snack bars produced in our study are shown in Figure 1. All products that completed the drying process were packaged in sterile polypropylene packages and then stored for physicochemical, microbiological and sensory analyses.



Figure 1. A; Control,B; Prebiotic and C; Symbiotic snacks bar samples

### 2.2.1. Analysis

Total solids and protein contents of the snack bar samples were determined according to the Association of Official Analytical Chemist methods by the gravimetric method and Kjeldahl method respectively [16,a,b]. Snacks bar samples of pH values were performed using a pH meter. The sensory properties of snacks bar samples on were conducted according to the modified method of Bodyfelt (1988) by a panel of 8 participants (from Secen Bakery Products Agriculture Food Tourism Construction Contracting Trade Industry R&D Department) who were trained on the sensory testing procedure. All snacks bar samples were presented with a three-digit code. The scale applied in the sensory test shown in Figure 2 ranging which ranges from 1 (extremely low) to 9 (extremely high) was used to evaluate the sensory quality [17]. *L. rhamnosus* GG used as a probiotic strain in symbiotic bars was counted. *L. rhamnosus* GG counting was performed on MRS and MRS agar containing 0.05% (w/v) cysteine using the pour plate method. Samples cultivated at appropriate dilutions were incubated at 37 °C under anaerobic conditions for 72 hours [18]. Analyses of snack bars were carried out the day after production.



**Sensory Analysis Form For Snack Bar**

Samples	Appearance	Colour	Smell	Taste	General Appreciation
A					
B					
C					

(9) I liked it a lot

(8) I liked it quite a bit

(7) I liked it a little

(6) I liked it moderately

(5) I neither liked it nor disliked it

(4) I disliked it a little

(3) I disliked it moderately

(2) I disliked it

(1) I disliked it very much

Figure 2. Sensory analysis form used in the study

### 3. Result

The contents of total solids and protein in snacks bar were 86.90-89.21%, and 20.85-21.78%, respectively. The composition of snacks bar is given in Table 1. The total solids and protein values of all snacks bar samples were close to each other.

Table 1. Data on total solids (%), protein (%), pH values and *L. rhamnosus* GG count (log cfu/g) in determined of snacks bar samples (mean±standard deviation)

Samples	Total Solids (%)	Total Protein (%)	pH Values	<i>Lactobacillus rhamnosus</i> count GG (log cfu/g)
Control	87.75±0.4	21.00±0.08	6.00±0.02	n.d.*
Prebiotic	89.21±0.52	20.85±0.65	6.30±0.01	n.d.*
Symbiotic	86.90±0.25	21.78±0.06	5.80±0.00	8.05±0.35

\*n.d.;not determined.

In the *L. rhamnosus* GG count carried out because of the production of symbiotic snack bars, it varied from there were 8.05 log cfu/g bacteria in the product.

The average scores given by the panelists regarding the appearance, color, odor and properties of the snack bar samples samples in the sensory analyses performed on as seen in Table 3. In the sensory analyses performed snacks bar samples received similar scores from the panelists.



Table 2. Data on sensory analyses of snacks bar samples (mean±standard deviation)

Samples Parameters	Control	Prebiotic	Symbiotic
Appearance	7.50±0.04	7.60±0.06	7.40±0.03
Colour	7.30±0.09	7.50±0.07	7.20±0.05
Smell	7.20±0.08	7.40±0.05	7.30±0.01
Taste	7.10±0.03	8.00±0.04	7.20±0.02
Acceptability	7.30±0.09	7.80±0.02	7.40±0.03

Sensory evaluation results indicated that the control, prebiotic, and symbiotic snacks bars received similar scores for appearance, color, and odor. The prebiotic bar sample achieved the highest taste score. Overall taste scores revealed that the prebiotic sample had a higher average score than the other groups. These results suggest that the addition of the prebiotic ingredient had a positive impact on the product's taste and acceptability, but the symbiotic formulation exhibited sensory characteristics like the control sample.

#### 4. Discussion and Conclusion

This study aimed to develop symbiotic bar formulations with functional properties. The analysis findings of the snack bars are consistent with similar studies in the literature. The total solids and protein contents of all samples were found to be similar (approximately 87-89% total solids and 20-22% protein). This demonstrates that the formulation ingredients are nutritionally balanced. Furthermore, the high protein and fiber content suggests that the bars are comparable to products found in the sports nutrition and functional food markets [6,8].

The determination of a viable *L. rhamnosus* GG count of 8.05 log cfu/g in the symbiotic bar sample demonstrates the product's probiotic efficacy. This result is consistent with studies emphasizing the role of WPC in maintaining the viability of probiotics [14]. The high bioavailable protein content of WPC maintains the structural integrity of the food matrix and increases the stability of probiotics in gastrointestinal conditions [15]. This finding suggests that symbiotic combinations (prebiotic + probiotic) are promising in functional food formulations [5]. According to sensory analysis results, no significant differences were found between the appearance, color, and odor characteristics of the control, prebiotic, and symbiotic bar samples, while the symbiotic bar sample received the highest taste and overall liking scores. This result is like studies showing that prebiotic



fibers such as inulin improve the taste and texture of the product [15,17]. In contrast, the panelists evaluated the symbiotic sample's taste score as being higher, which may be due to the slightly acidic taste created by probiotics during fermentation. Overall, the prebiotic additive improved the product's sensory properties, while the symbiotic combination was found to increase its functional value. Thus, a high-protein functional snack that is both sensory and microbiologically satisfying was achieved.

This study contributes to the development of a product that meets increasing consumer awareness, healthy lifestyle trends, and the demand for "portable functional foods" [1,6,7]. Such "clean-label" products, particularly those combining proteins, fibers, and probiotics, are believed to have high market potential. Future studies should examine the storage, textural changes, and viability of probiotics throughout the shelf life of such bars. In conclusion, the symbiotic bar formulation developed in this study was found to be successful in terms of both nutritional value and probiotic viability. The development of such products is believed to meet consumer expectations by offering innovative, healthy, and sustainable alternatives in the functional food market.

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