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Evaluation the production of dietary curcumin milk containing inulin fiber and enriched with protein

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ABSTRACT

Golden Milk is a low-calorie product with reduced sugar, high protein content, and contains inulin fiber, curcumin, WPC and MPC proteins, carrageenan gum, black pepper, sugar, and stevia as a sweetener, flavored with honey and cinnamon. It's suitable for everyone, especially athletes, and is considered a functional food product. We examined three treatments with varying protein percentages (5% whey and 1% caseinate, 5% caseinate and 1% whey, 3% caseinate and 3% whey, and a control). Following experiments and satiety evaluations using the VAS method, the treatment with 5% caseinate and 1% whey was chosen for further stages due to caseinate protein's longer satiety effect and better sensory evaluation for mouthfeel and texture. We then explored rheological properties; viscosity, yield stress, consistency coefficient, and flow index, alongside overall acceptance for three treatments with different inulin fiber amounts (1, 1.25, and 1.5 grams per kilogram). The sample viscosities were 43.75, 45.91, and 47.12 centipoise, while the control was 40.23 centipoise. Flavored milks typically average around 15 centipoise due to lower protein and fiber absence. Consistency coefficient and flow index increased with fiber content. In taste tests, the sample with 1 gram of inulin fiber scored highest in sensory evaluation (4.25±0.5) compared to 1.25 and 1.5 grams of fiber (3.77±0.8 and 3.5±0.8, respectively). Upon achieving an optimal formulation, the product's physicochemical properties; protein, caloric value, and sugar content were measured at 7%, 90 kilocalories, and 6%, respectively.

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1- Introduction

In recent years, especially after the outbreak of the coronavirus, turmeric has gained special attention due to its therapeutic properties and immune-boosting effects. There is also a growing demand for a functional and low-calorie beverage among various groups, including athletes, the elderly, and children. Therefore, the production of products with these features is particularly important. Inspired by turmeric milk, a popular beverage among the people of India, Alis Company has produced a functional and enriched product called Golden Milk, which contains curcumin (the active compound in turmeric), black pepper, inulin fiber, protein, and the natural sweetener stevia. This product aims to improve body performance and health by reducing fat and sugar content to the lowest possible levels.

Curcuminoids, natural polyphenols that include curcumin and its derivatives, have been studied for their potent antioxidant activity, anti-inflammatory properties, and anti-tumor properties, as well as their potential in treating autoimmune disorders such as type 1 diabetes, intestinal diseases, arthritis, and certain cancers [1-3]. Inulin, as a water-soluble fiber, has been shown in previous research to stimulate the growth of beneficial bacteria like bifidobacteria and reduce harmful bacteria as a prebiotic. Additionally, this fiber creates a feeling of fullness, helps with weight loss, lowers blood cholesterol, and improves digestive system function [4]. The proteins used in this product include whey protein and casein. Meals containing provide a better sense of satiety. Halton et al. (2004) high-protein meals can aid in weight loss and slow down the rate of weight gain [5]. Proteins have unique properties related to their amino acid content, structure, and absorption and digestion rates. For instance, research has shown that whey protein, compared to other proteins like casein (another milk protein), contains a higher amount of leucine, which is digested faster and leads to a rapid increase in amino acid levels in the body, which is crucial for muscle building. Therefore, it is recommended for use immediately after exercise. Casein, on the other hand, is a slower-digesting protein and is recommended for consumption before sleep. Thus, different proteins have diverse metabolic effects, and their impact on appetite and energy consumption varies [6]. As Pal and colleagues demonstrated in 2014, whey protein supplements, compared to casein and carbohydrate supplements, had a better effect on satiety and feelings of fullness after meals in overweight and obese individuals [7]. Moreover, black pepper is an excellent source of magnesium, vitamin K, iron, and fiber, has antibacterial, antioxidant, immune-boosting, and antipyretic properties [8]. Stevia, as a natural sweetener and suitable substitute for refined sugar, helps with weight loss and blood pressure reduction, making it suitable for diabetic patients [9].

The main aim of the current research was to determine the optimal amount of casein and whey protein, as well as the amount of inulin fiber, to examine their effects on appetite and the feeling of fullness over a two-weeks period in humans. The digestive system's performance and the textural, sensory, and overall acceptance properties of each treatment with different protein and fiber percentages were evaluated. This research contributes to the production of healthier and functional food products that promote public health, reduce chronic diseases, and meet the nutritional needs of athletes.

2-Materials and methods

1-2- Materials

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The raw materials used in this product include 3% fat milk, curcumin, WPC[1] and MPC[2] proteins, inulin fiber, carrageenan gum, phosphates, sugar, and stevia as a sweetener, flavored with honey and cinnamon. The type of fiber used in this research is a water-soluble fiber that dissolves in the stomach and forms a gelatinous substance that slows down digestion. This increases the feeling of fullness and is very beneficial for those seeking weight loss diets, making it a health-oriented product based on weight management.

2-2- Methods

1-2-2- Preparation and formulation

In the first phase of producing curcumin milk, samples were produced without whey protein and caseinate as a control, along with three treatments containing different amounts of whey protein and caseinate: 5% whey protein and 1% caseinate (Treatment 1), 5% caseinate and 1% whey protein (Treatment 2), and equal amounts of 3% of both proteins (Treatment 3) (Table 1). The purpose of designing these treatments was to examine the appetite-curbing effect of these two proteins, to select the ratio that provides a greater feeling of fullness along with a high sensory score for the final formulation.

2-2-2- Selecting the evaluator and test group

Among 100 candidates, 11 men and women with normal weight and a body mass index (BMI) between 18.5 and 24.9 kg/m² were selected for each of the four treatment groups (Table 1) through Alis Company's recruitment. Participants, aged 18 to 45, were screened by answering a form that inquired about their weight, height, age, specific diseases (such as diabetes, hypothyroidism or hyperthyroidism, cardiovascular diseases), use of lipid-lowering drugs, steroids, and other factors that might impact fat metabolism.

Table1. Subject characteristics at baseline

	Control	Whey>Casein	Casein>Whey	Casein=Whey
Gender (Male/Femail)	9/2	8/3	10/1	9/2
Age	38±1.5	37.2±2.1	37.5±2.0	38.1±1.7
Weight (Kg)	72.2±1.8	71.8±1.5	72.4±0.7	72.4±1.6
BMI (Kg/m^2)	20.6±0.8	20.4±0.9	21.2±0.8	21.8±0.9

3.2.2. Appetite rating based on visual analog scale (VAS)

Over a two-week period, participants' appetite levels were evaluated twice daily while they adhered to a consistent diet. The specified protein-containing product was provided as a snack at 10 AM. Using the Visual Analog Scale (VAS), appetite assessments were conducted immediately before lunch at 2 PM and before dinner at 8 PM, resulting in a single measurement per participant each day. The VAS features 100-millimeter lines with contrasting phrases at each end. Participants indicated their current feelings by marking a point on the line, and the score was determined by measuring the distance in

[1] Whey Protein Concentrate

[2] Milk protein concentrate

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millimeters from the start of the line to the marked point (from left to right) [6].

4.2.2. Evaluators' Satiety Assessment Test

Selected evaluators were given this product once daily for 14 days. According to published research, the digestion time for casein is 5 to 7 hours, while whey protein takes 1 to 2 hours. The evaluators' feeling of satiety was assessed using the Visual Analogue Scale (VAS) during lunch and dinner by responding to the following questions: "How hungry do you feel?" (I've never been this hungry – I'm not hungry at all), "How satisfying is this feeling of fullness for you?" (I'm completely hungry – I can't eat another bite), "How full do you feel?" (Not full at all – Completely full), "How much do you feel like eating?" (A lot – Not at all), and "How much food do you think you can eat right now?" (A lot – Not at all). A score of zero indicated that the evaluators were "not full at all," while a score of 100 indicated they were "very full." Scores between these two extremes represented the degree of satiety, with higher scores indicating greater feelings of fullness [10].

5.2.2. Sensory evaluation test of protein treatments

Panelists tasted the samples and recorded their opinions on a scale of zero to ten for taste (zero - bad, 10 - very good) and consistency (zero - dilute, 10 - concentrated).

6.2.2. Preparation and formulation of phase 2

After reviewing the scores, the optimal protein ratio was selected. Considering the sensory properties of various dietary fibers, the inulin-containing samples received the highest taste scores. At this stage, fiber was added to the formula in three different percentages within the permissible range due to its effects on the digestive system. The sensory evaluations by the assessors determined the best amount. According to the guidelines for functional foods and voluntary fortification by the Food and Drug Administration, products containing 1% to 1.5% fiber are approved. Thus, fiber amounts of 1%, 1.25%, and 1.5% were used as treatment samples, while a sample without fiber served as the control in phase two. Subsequently, viscosity, yield stress, flow behavior index, consistency coefficient, and finally mouthfeel and texture were examined.

7.2.2. Viscosity, yield stress, consistency coefficient, and flow index

The apparent viscosity of each sample was measured using a Brookfield viscometer (Model COM LV, Brookfield Inc., USA) with spindle SC4-18, over a shear rate range of 1 to 123 s^{-1}, reported in millipascal seconds (mPa·s) at a temperature of 25°C. These measurements were conducted at the Food Science and Technology Research Institute in Mashhad. The viscosity was ultimately reported at a shear rate of 45 s^{-1}. The factors of yield stress, consistency coefficient, and flow behavior index were calculated using both the Herschel-Bulkley model and the power law model, with the aid of Origin 2021 software.

8.2.2. Sensory Analyzing

Eleven evaluators were selected for the sensory evaluation, and using the 5-point Hedonic scale, they assessed the prepared milk samples in terms of appearance, texture, aroma, taste, and overall acceptance. A score of 5 indicated "excellent" and a score of 1 indicated "very bad" [11].

After the sensory, textural, and satiety evaluations and the selection of the optimal formulation, physicochemical tests were conducted on the samples.

9.2.2. Physicochemical tests

1.9.2.2. Total Fiber Measurement

In accordance with ISIRI 3105, the sample was first crushed and degreased, then boiled

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in an H_2SO_4 solution of a specified concentration. After that, separation and washing were conducted. Finally, the sample was dried, the insoluble residue was weighed, and the mass loss due to burning was measured [12].

2.9.2.2. Protein measurement

Using the Kjeldahl method and ISIRI 639, the sample was digested with concentrated sulfuric acid in the presence of a catalyst. The released ammonia was collected after undergoing an alkaline reaction and distillation. Ultimately, the nitrogen content and the crude protein content were determined [13].

3.9.2.2. Total dry matter measurement

According to ISIRI 637, 4 to 6 grams of the sample were weighed and placed in an oven until a constant weight was achieved. Then, the amount of dry matter was calculated using the formula [14].

4.9.2.2. Sucrose measurement

According to ISIRI 12184, the amount of sucrose in milk products was calculated in grams per 100 grams of the sample. In the first step, fat and protein were separated, and sucrose was broken down into glucose and fructose. The total glucose amount was then measured using the spectrophotometry method at a wavelength of 340 nanometers. This amount corresponds to the total glucose present (glucose derived from sucrose and free glucose). Additionally, the free glucose in the sample was also measured using the same method. The difference in absorbance obtained from the two tests correlates with the glucose derived from sucrose, which was used to determine the amount of sucrose [15].

5.9.2.2. pH measurement

In accordance with ISIRI 2859, the pH measurement was performed by transferring the sample into a 30 ml or 50 ml container at 20°C. The pH meter electrode was fully immersed in the sample for at least 45 seconds, after which the reading on the pH meter was recorded [16].

6.9.2.2. Fat measurement

In accordance with ISIRI 384, milk protein was first dissolved using concentrated H_2SO_4, and then fat particles were separated using centrifuge force and adding a small amount of isoamyl alcohol, and the fat content was measured with a fat meter [17].

7.9.2.2. Measurement of cholesterol and plant sterols

In accordance with ISIRI 9670, sterol fraction was separated using thin-layer chromatography, and its qualitative and quantitative analysis was conducted using gas chromatography at the Food Science and Engineering Research Institute [18].

8.9.2.2. Measuring calories content

According to ISIRI 8867, the calorie content of the product was measured by the Meyar-Gostar Isfahan laboratory after it was burned in a bomb calorimeter. The measurement was based on the increase in the temperature of the water inside the calorimeter's tank [19].

9.9.2.2. Microbial tests

In accordance with standard 2406, the total microbial count, including *coliforms*, *Escherichia coli*, coagulase-positive *Staphylococcus aureus*, *Salmonella*, and mold and yeast, was performed at the Alis Microbial Laboratory. The acceptable limits are 2×10^4, 10, negative, negative, negative, and 10^2, respectively [20].

10.2.2. Statistical evaluation

The data were presented as mean (± standard deviation) and analyzed using one-way ANOVA at a significance level of 0.05, using SPSS software version 17. For pairwise

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comparisons between groups, the Tukey test was used.

3- Result and Discussion

1.3. Investigation of satiety, sensory evaluation, and texture of products with different protein percentages

Out of the applicants for sensory evaluation, a total of 44 men and women were selected, with 11 individuals in each of the four groups mentioned above. The VAS test results indicated that a higher According to the results in Table 2 and the VAS test, a higher percentage of casein protein compared to whey protein in the product resulted in a longer-lasting feeling of satiety (greater satiety before dinner). In contrast, the effect of whey protein was more noticeable in the short term and before lunch, although casein also had an acceptable short-term effect. As observed in the study by Pezeshki et al. (2015), casein and whey proteins are the main proteins found in dairy products and differ in their digestion and absorption due to differences in amino acids and composition. Whey protein is rapidly absorbed and causes a transient increase in plasma amino acid levels, while casein coagulates in the acidic environment of the stomach, delaying gastric emptying and resulting in a gradual and prolonged increase in plasma amino acid levels. Some studies have shown that whey is more satiating than casein [22, 23], although different results exist in the references [24, 25]. Similarly, there is no clear evidence of the superiority of one dairy protein over another when examining their effects on energy consumption. One study showed that subjective feelings of satiety from casein and soy were greater than from whey, but whey was more acceptable compared to casein and soy [23]. Results indicate that various protein sources can be used to modulate metabolism and subsequently energy balance.

Based on existing research, their appetite-suppressing effects are likely due to the secretion of satiety hormones. These proteins stimulate amino acid uptake in cells via insulin, which can also explain their impact on satiety. Incretins are hormones derived from the gut that are released in response to nutrient intake and increase insulin secretion by stimulating specific receptors on β-cells. Whey proteins may act through two main incretin hormones, glucagon-like peptide 1 (GLP-1) and glucose-dependent insulinotropic polypeptide (GIP), both of which play a significant role in insulinotropic intestinal peptides [26].

The feeling of satiety among the evaluators was acceptable for both the "equal casein and whey" and the "more casein than whey" treatments. Sensory evaluation and mouthfeel, based on Figure 1, showed that Treatment 1 (sample with 5% whey protein and 1% casein protein) and Treatment 3 (sample with 3% casein protein and 3% whey protein) were almost the same in terms of taste and slightly better than Treatment 2 (sample with 5% casein protein and 1% whey protein). However, Treatment 2 was better evaluated in terms of texture. As a result of these evaluations, Treatment 2, which means "more casein than whey" was selected for the next stages, where the appropriate fiber content will be determined considering the relevant parameters.

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Table2. Sensations of appetite measured by the Visual Analogue Scales before lunch and dinner in days 0,7,14.

Groups	Before Lunch			Before Dinner		
	Day0	Day7	Day 14	Day0	Day7	Day14
How hungry do you feel?						
Control	48.9±2.5	49.1±2.8	49.7±3.1[a]	57.5±3.2	58.1±3.1[a]	58.3±3.1[a]
Whey>Casein	40.4±3.8	40.2±3.9	39.9±3.1[a]	45.4±2.2	45.8±3.2	44.8±2.8[a]
Whey<Casein	41.5±4.1	41.3±3.9	41.8±4.2	41.7±4.4	41.7±4.1	41.8±4.0
Whey=Casein	41.1±4.3	40.9±3.7	41.2±3.8	43.8±4.5	42.9±4.3[a]	43.6±3.9
How satisfied do you feel?						
Control	54.7±3.3	54.4±4.5	55.2±4.8[a]	50.2±4.5	50.5±4.1	49.7±3.9[a]
Whey>Casein	59.2±4.1	58.5±4.0[a]	57.9±4.5[b]	52.2±3.8	52.7±3.5[a]	53.1±2.9[b]
Whey<Casein	58.1±2.6	57.7±2.6	56.8±4.2[a]	59.6±2.4	60.7±3.7[a]	60.9±3.4[b]
Whey=Casein	58.3±3.1	58.5±3.6	57.8±3.2[a]	58.4±4.3	59.2±3.9 [a]	59.8±3.5 [b]
How full do you feel?						
Control	54.7±3.6	54.9±4.2	55.0±4.1	51.6±2.5	52.1±2.1[a]	52.4±2.4[a]
Whey>Casein	57.1±3.6	56.4±3.5[a]	56.1±3.3[a]	54.7±3.1	54.9±3.2	55.2±3.8[a]
Whey<Casein	56.2±4.2	55.8±3.7	55.9±3.9	58.9±3.4	58.7±2.7	59.5±3.1[a]
Whey=Casein	53.7±2.5	53.2±2.7[a]	53.8±3.2	54.1±2.3	54.5±2.3	54.1±2.4
How strong is your desire to eat?						
Control	60.2±2.7	59.8±2.9	60.5±2.6	66.4±3.1	62.5±3.4[b]	65.8±3.1[a]
Whey>Casein	52.4±3.4	52.8±3.4	51.8±3.7[a]	53.8±3.5	54.7±3.4[a]	54.5±2.8[a]
Whey<Casein	52.2±2.4	52.7±2.5[a]	52.4±2.9	50.0±2.8	49.8±3.4	50.4±2.5
Whey=Casein	52.4±3.2	52.5±3.4	52.8±2.4	50.8±2.6	51.2±2.8	51.7±3.1[a]

Data are means ± SEM (control n=11; Whey>Casein n=11; Whey<Casein n=11; Whey=Casein n=11) of various questions of the absolute values (mm) from the VAS (Visual Analogue Scale) at day 0, day7 and day14. Statistical significance between groups is indicated by different letters, with comparisons made from day0 at $P < 0.05$. Data were analyzed using the general linear model and difference was assessed by the Tukey's test.

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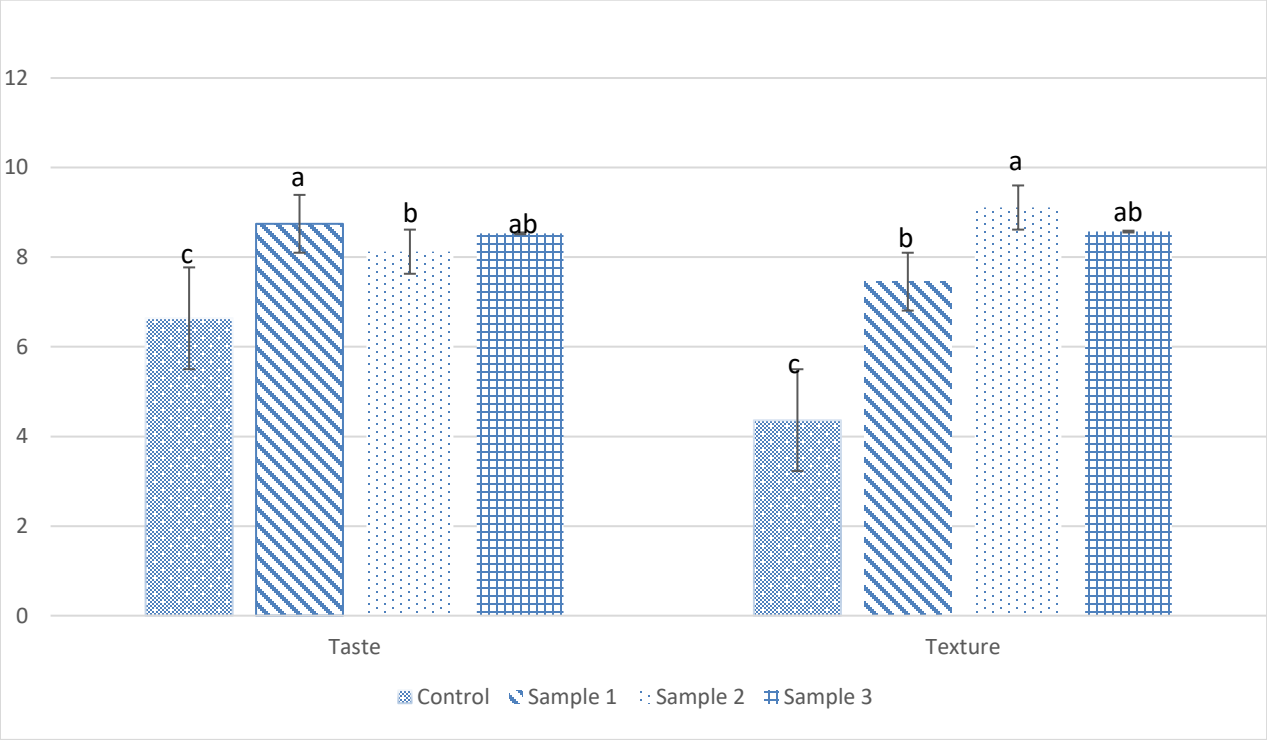

Figure 1. Sensory Analysis by Hedonic evaluation Method. Different lowercase letters in each title “Taste” and “Texture” indicate a significant difference between the data (p≤ 0/01).

2.3. Investigation of the rheological, textural, and sensory properties of the product with inulin fiber

The evaluators assessed the product with specified amounts of whey protein and casein along with 1%, 1.25%, and 1.5% inulin fiber. The viscosity of the product, measured using a viscometer, increased with higher fiber content, as shown in Table 3. Inulin acts as an excellent fat replacer in various dairy products. Its ability to substitute fat not only affects rheological behavior but also other mouthfeel attributes like creaminess or the absence of sandiness. Following the measurement of apparent viscosity, consistency coefficient, flow index, and yield stress of the treatments, a sensory evaluation was conducted by 11 trained assessors using the hedonic method (Table 3). The average viscosity of Golden Milk at 25°C was 45 centipoises, while other flavored milks from Alis, such as chocolate milk, coconut milk, banana milk, and coffee milk, measured 10.38, 15.48, 15.96, and 13.84 centipoises, respectively, as reported by the Research Institute of Food Science and Technology. Among the three defined treatments at this stage, Treatment 1 was selected based on the evaluators' scores for better mouthfeel. Although Treatments 2 and 3 had higher viscosities, Treatment 1, with 1% fiber, received the highest score, possibly due to the presence of 7% protein in the mix and its impact on the texture of the Golden Milk, as well as the natural fat of the milk. Research by Wang et al. [26] indicates that the addition of whey protein enhances textural properties and prevents serum separation due to hydrophobic interactions with milk casein micelles and the formation of casein-whey protein complexes. Consequently, with whey protein in Golden

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Milk, a smaller amount of inulin can rapidly achieve the desired texture, while higher fiber levels may lead to diarrhea [27]. Additionally, Guven et al. [28] found that adding inulin up to 1% improved sensory properties compared to the control, while further addition of up to 3% reduced sensory characteristics. Inulin improved the apparent viscosity of Golden Milk and enhanced its creamy mouthfeel. It is believed that inulin, as a fat replacer, has the ability to form microcrystals that interact with each other, creating small granules. These granules trap a significant amount of water, resulting in a smooth and creamy texture [29]. Inulin, as a texture enhancer, forms microcrystals that create a gel-like structure responsible for the creamy texture of the product. In Figure 2, the shear stress behavior of the product containing 1% inulin fiber against increasing shear rate is shown. This chart indicates pseudoplastic fluid behavior, meaning that the viscosity of this fluid is not constant and depends on the shear rate [30]. In both charts, the curves at low shear rates (close to zero) exhibit steeper slopes. This steeper slope indicates that in this region, shear stress rapidly increases with an increase in shear rate, meaning higher viscosity. As the shear rate increases, the slope of the curves gradually decreases, indicating that with an increase in shear rate, the increase in shear stress becomes less significant, and in other words, the viscosity of the fluid decreases. The pseudoplastic behavior of this fluid is well-described by the Herschel-Bulkley and Allometric models, and the parameters of these models help us quantitatively determine the changes in viscosity.

In a study [31], inulin did not show a significant effect on the firmness index (quantifies the amount of force required to deform or penetrate the product), and only the samples containing 3.5% fat were significantly firmer than the other samples. These results somewhat align with the rheological data, where both the effects of inulin and fat can be observed. Considering this and the 3% fat milk used in Golden Milk, as well as the results obtained from viscosity and sensory evaluation at this stage, using 1% inulin in 3% fat milk, along with added whey protein and casein, will yield the best results.

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Table3. Viscosity, Yield stress, Consistency Coefficient, Flow Behavior Index, Final sensory analysis

					Herschel-Bulkley		Allometric	
Samples	Inulin Percentage	Average Sensory Analysis score	Viscosity (45/s Shear velocity)	Yield stress (Pa)	Flow Behavior Index	Consistency Coefficient	Flow Behavior Index	Consistency Coefficient
Control	0	3.5±0.7^{c}	40.23^{c}	0	0.60253^{b}	0.17645	0.60423^{b}	0.17668
Sample1	1	4.25±0.5^{a}	43.75^{b}	0	0.62449^{ab}	0.18174	0.62286^{a}	0.17995
Sample2	1.25	3.77±0.8^{b}	45.91^{ab}	0	0.63228^{a}	0.18256	0.62562^{a}	0.18214
Sample3	1.5	3.5±0.8^{c}	47.12^{a}	0	0.63845^{a}	0.18427	0.62823^{a}	0.18502

Different lowercase letters in each column indicate a significant difference between the data (P≤0.01)

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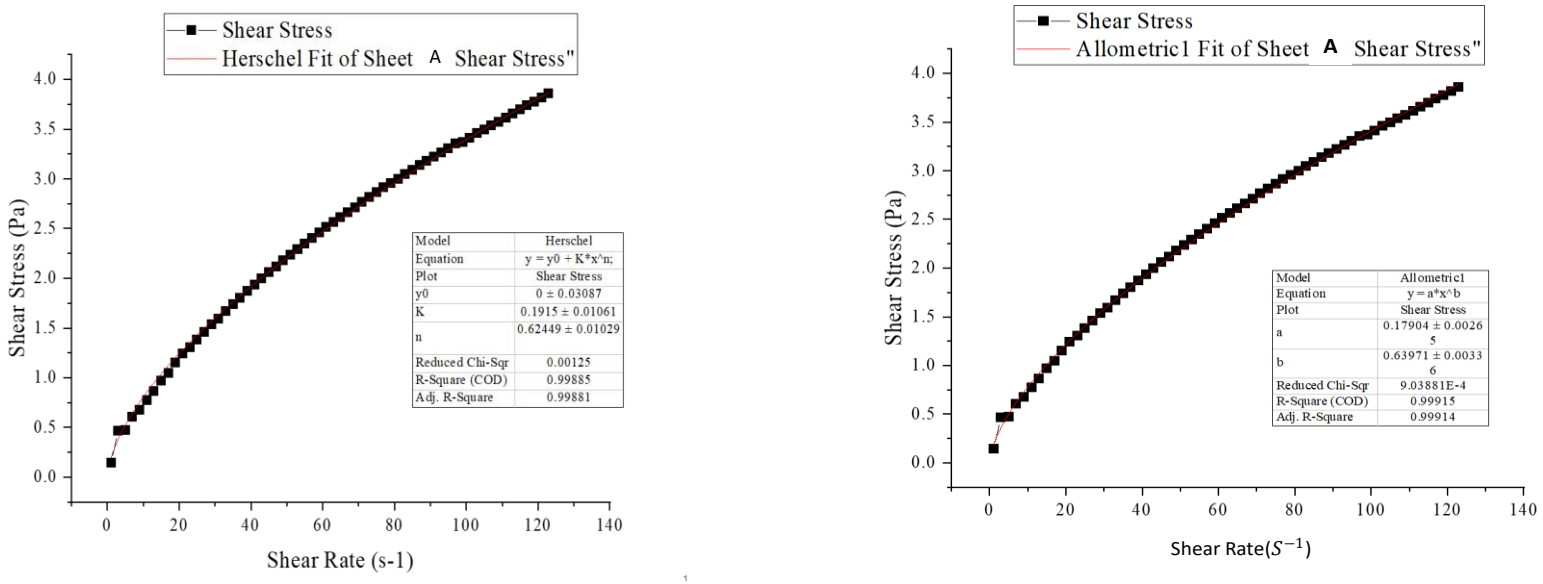

Figure2. Shear stress diagram in terms of shear rate in treatment with 1% of fiber (pseudoplastic fluid)

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3.3. Evaluation of the physicochemical and microbial properties

In the evaluation of the physicochemical properties of the final product, with several parameters listed in Table 4, the amounts of fiber and protein were first measured according to existing standards. These values were consistent with the product formulation. The most abundant fatty acids in Golden Milk included palmitic acid (36.85%), stearic acid (11.81%), and myristic acid (11.07%). The percentages of cis and trans fatty acids were 27% and 1.5%, respectively. Due to the dietary nature of the product, its sucrose content was approximately 2.5%, which is lower compared to flavored milks that typically report 6 to 7%. Additionally, the total sugar in Golden Milk is reduced by 1 to 2%. Golden Milk, being rich in protein and fiber, has a higher dry matter content compared to other milks; unflavored milk has 8%, flavored milks like chocolate milk have 15 to 18%, and Golden Milk has 25% dry matter.

Microbial tests showed that the product complies with standards and is free from *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella*.

Table4. Physicochemical Characteristics of Golden Milk

Factors	Saturated fatty acid	Unsaturated fatty acid	cholesterol	Other Sterols	pH	acidity (in terms of lactic acid)	Total Sugar	Brix	Fat	**Calorie (Kcal/100)**
Golden Milk	71%	28.8%	98%	1.32%	6.7	0.17	6.67	25%	3%	**90**

4.3. Conclusion

The results of this study showed that casein protein has a long-term satiating effect, while whey protein has a short-term effect. Casein protein had a more favorable impact on the texture of the final product, whereas whey protein showed a better effect on taste and flavor. Consequently, both types of protein were used in specific proportions in the product formulation. When inulin fiber is added to a product without fat and added protein, proportions above 1% improve and soften the texture. In the produced product, given its high protein content and the fat percentage of the milk used, using a high fiber percentage led to lower acceptance in related sensory evaluations. As a result, with the positive impact of approximately 1% inulin on texture, this amount was selected. The physicochemical properties of the final product were compared with other milks (unflavored and flavored milks). Due to the dietary nature of the product, its sucrose and total sugar content are lower than those of other milks. Additionally, due to the use of protein and fiber in the formulation, its dry matter content is higher.

Future research could focus on fortifying Golden Milk with vitamins and essential amino acids that the body cannot produce. Additionally, functional beverage desserts based on turmeric and high in protein could be formulated.

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بررسی تولید شیرکورکومین رژیمی حاوی فیبر اینولین و غنی شده با پروتئین

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چکیده

شیر طلایی، محصولی کم کالری با شکر کاهش یافته، حاوی درصد بالایی پروتئین به همراه فیبر اینولین،کورکومین، پروتئین‌های WPC و MPC، صمغ کاراگینان، فلفل سیاه، شکر و استویا به عنوان شیرین کننده، طعم دهنده عسل و دارچین است که برای تمامی گروه‌ها به ویژه ورزشکاران مناسب بوده و یک محصول فراسودمند محسوب می‌شود. سه تیمار با درصدهای مختلف پروتئین(۵ درصد آب پنیر و ۱ درصد کازئینات، ۵ درصد کازئینات و ۱ درصد آب پنیر، ۳ درصد کازئینات و ۳ درصد آب پنیر و شاهد) در نظر گرفته شد. پس از انجام آزمایشات و بررسی سیری افراد به روش VAS، تیمار شماره۲ به دلیل میزان سیری بیشتر پروتئین کازئینات در طولانی مدت نسبت به پروتئین آب پنیر و همچنین احساس دهانی و بافتی بهتر آن در ارزیابی حسی، برای مراحل بعدی انتخاب گردید. سپس با مقدارهای متفاوت فیبر اینولین در سه تیمار با ۱، ۱/۲۵ و ۱/۵ گرم در ۱ کیلوگرم، خصوصیات رئولوژیکی شامل ویسکوزیته، تنش تسلیم، ضریب قوام و شاخص جریان و همچنین پذیرش کلی آن بررسی شد. ویسکوزیته نمونه ها به ترتیب ۴۳/۷۵، ۴۵/۹۱ و ۴۷/۱۲ و نمونه کنترل ۴۰/۲۳ سانتی پواز گزارش شد که این پارامتر در شیرهای طعم دار به دلیل درصد پروتئین کمتر و عدم وجود فیبر به طور متوسط ۱۵ سانتی پواز است. ضریب قوام و شاخص جریان با افزایش مقدار فیبر، افزایش یافت. همچنین در تست طعم آن‌ها مقدار ۱ گرم فیبر اینولین بالاترین امتیاز ارزیابی حسی (۴/۲۵±۰/۵) را در مقایسه با ۱/۲۵ و ۱/۵ گرم فیبر(به ترتیب برابر با ۳/۷۷±۰/۸ و ۳/۵±۰/۸) به دست آورد. پس از دستیابی به فرمولاسیون بهینه برای این محصول، ویژگی‌های فیزیکوشیمیایی آن از جمله پروتئین، میزان کالری و قند آن که به ترتیب برابر با ۷ درصد، ۹۰ کیلوکالری و ٦ درصد بود، اندازه گیری گردید.

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