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SHORT COMMUNICATION

DEVELOPMENT AND QUALITY EVALUATION OF OAT (*Avena sativa*) INCORPORATED DRINKING YOGURT

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ABSTRACT

Oat (*Avena sativa*) is a healthy cereal that is high in fiber and minerals. This research aimed to develop an oat powder incorporated drinking yogurt. 0.25, 0.50, and 1.0 g of oat powder per 100 ml of milk were selected as concentrations. Gelatin was not included due to the stabilizing ability of oat powder. To evaluate consumer preference and proximate analysis, oat concentration selected from a sensory evaluation was compared to a commercial drinking yogurt. For a period of 21 days, physicochemical (pH, Titratable acidity, and Total soluble solids) properties and microbiological quality were examined. The data was statistically analyzed using SSPS and SAS at a significance level of $P<0.05$. The most consumer-preferred oat concentration was 0.5 g oat powder per 100 ml of milk, with sensory properties identical to commercial drinking yogurt. The fat (3.43), protein (3.30), solids non-fat (26.08), and fiber (0.05) contents of the selected oat concentration were significantly higher than those of the commercial drinking yogurt. According to the yeast and mold count, oat drinking yogurt had a shelf life of 14 days after manufacturing. In conclusion, oat powder including drinking yogurt can be developed with better sensory properties which is competitive with commercial drinking yogurt.

Keywords: *Avena sativa* (*oat*)**,** *Drinking yogurt, Physicochemical properties, Proximate analysis*

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1. INTRODUCTION

Oat (*Avena sativa*) is a cereal with many health benefits due to its nutritional and functional properties. β-glucan, avenanthramides, tocols, sterols, phytic acid, and avenacosides are bioactive compounds found in oat. These compounds have shown promise in the prevention of heart diseases, diabetes, and cancer [1]. Because of these functional properties, it is used to improve the nutritional value of a variety of foods and

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and as a dietary therapy for a variety of health problems. Oats are used in breakfast cereals, bakery items, and infant foods, although more advanced inventions of oat incorporated food are rare [2]. According to numerous studies, β - glucan in oats has hypoglycemic qualities, which can aid diabetes patients by stimulating insulin secretion and lowering the blood sugar level [3]. It also aids in the decrease of LDL cholesterol levels in the blood [4]. Oats are effective as a functional diet in preventing cardiovascular diseases, improving intestinal function, and controlling obesity [5]. Interestingly, combining oats and dairy products has become an innovative strategy in the food sector.

Yogurt is a popular fermented dairy product with functional properties that help people struggling with obesity, enhance their gut health, and prevent diabetes [6]. Drinking yogurt has become very popular in modern society as a beverage that may also be used as a breakfast meal [7]. Oat flake-incorporated set yogurt has been developed with good sensory properties which is competitive with commercially available set yogurt [8]. Incorporating oats with drinking yogurt will create a functional ready-to-drink beverage. This study aimed to develop an oat-incorporated drinking yogurt as a nutritious functional beverage that could assist to reduce chronic diseases in the Sri Lankan community.

2. MATERIAL AND METHODS

2.1 Materials

Oat flake powder was prepared by grinding oat flakes using a domestic grinder (Preethi, India) and sifting through a sieve of 425 µm. Full cream fresh milk, sucrose, non-fat milk powder, and potassium sorbate (INS No. 202) were from local retail shops. *Streptococcus thermophillus* and *Lactobacillus bulgaricus* starter culture was purchased from the Veterinary Research Institute, Gannoruwa, Sri Lanka.

2.2 Preparation of oat incorporated drinking yogurt

The primary ingredients were sucrose (125 g), nonfat milk powder (10 g), and oat powder (Table 1). With 1000 ml of full cream fresh milk, all of the components were well mixed except starter culture and potassium sorbate. Gelatin was not added. The yogurt mixture was pasteurized at 90 °C for 30 minutes with constant stirring and then cooled to 45 °C. Potassium sorbate (300 mg/kg) and yogurt starter culture were introduced. The yogurt mixture was incubated at 42 °C for 4-5 hours until the pH reached

4.6 after which the coagulum was broken down by agitation and the mixture was refrigerated at 4 °C.

Table 1: Three different oat concentrations used to develop oat drinking yogurts

Treatment	Oat concentration (g per 100 ml of milk)
T1	0.25
T2	0.5
T3	1.0

2.3 Sensory evaluation

For the first sensory evaluation, a non-trained panel of 50 participants was selected from the university premises. Color, appearance, odor, sweetness, sourness, taste, overall quality, and purchasing intention were evaluated using a five-point hedonic scale (1 – Not acceptable, 2 – Poor, 3 – Fair, 4 – Good, 5 – Excellent). A non-trained panel of 30 people (from the previous panel) compared the selected oat concentration from the initial sensory evaluation to a commercial drinking yogurt sample.

2.4 Proximate analysis

AOAC, 2005 [9] was used to determine the moisture content (MC %), ash content, total solid content (TS %), crude fat content, and crude protein content. The crude fiber content was evaluated using a crude fiber analyzer and the solid non-fat content (SNF %) was determined using Sri Lanka standard 824 (1989) [10]. All the tests were done in triplicates. The energy content was calculated using the formula (Energy (kcal) = (weight of carbohydrate x 4 kcal/g) + (weight of protein x 4 kcal/g) + (weight of fat x 9 kcal/g) [11].

2.5 Shelf-life evaluation of oat incorporated drinking yogurt

2.5.1 Physicochemical properties

Physicochemical properties of yogurt samples stored under refrigerated conditions (4 °C) were evaluated. The pH of the yogurt samples was measured using a digital pH meter (Model: pp – 206, EZODO). A handheld refractometer (Model: ATAGO N – 46, Japan) was used to determine the total soluble solids (TSS) content as a percent value in Brix. The AOAC 947.05 method was used to evaluate titratable acidity (TA %) by titrating yogurt samples against 0.1 N NaOH with phenolphthalein as the indicator [9]. All the tests were done in triplicates. The tests were carried out at 3 day intervals for a total of 21 days.

2.5.2 Microbiological assessment

The microbiological evaluation was carried out for 21 days, with 7 day intervals. 10 ml of refrigerated (4 °C) yogurt sample was mixed with 90 ml peptone water solution and a dilution series up to 10^{-5} was prepared. The bacterial colony count and yeast and mold count were done with dilution 10^{-5}. The bacterial colony count was done on nutrient agar, whereas the yeast and mold count was done on potato dextrose agar. 0.1 ml of the dilute was spread on agar, which was then incubated at 37°C [10]. All the tests were done in triplicates.

2.6 Statistical analysis

Results of sensory evaluations were analyzed by the non-parametric analysis method (Kruskal Wallis test) by SSPS statistical software and parametric data analysis was conducted by Analysis of Variance (ANOVA) using SAS statistical software at $P<0.05$ significance level.

3 RESULTS AND DISCUSSION

3.1 Sensory evaluation

Except for color, odor and appearance, there was a significant difference ($P<0.05$) in sweetness, sourness, taste, texture, overall quality, and purchasing intention of oat drinking yogurts of three different levels of oat powder (Figure 1). Except for sourness, T2 (0.5 % oat powder) had the highest mean rank for all sensory attributes, while T3 (1.0 % oat powder) had the lowest mean rank for several sensory attributes (odor, sweetness, sourness, taste, texture, overall quality, and purchasing intention). Also, T2 had higher mean scores for texture, overall quality, and purchasing intention than T1. Thus, out of the three different oat levels, T2 (0.5 % oat powder) was selected as the most consumer preferable oat drinking yogurt treatment. It was the treatment with the second highest oat concentration. The treatment with the highest oat concentration was rejected due to a lower consumer preference for sensory attributes. The results reveal that the highest oat concentration which can be incorporated into drinking yogurt is 0.5 % with the highest consumer acceptability.

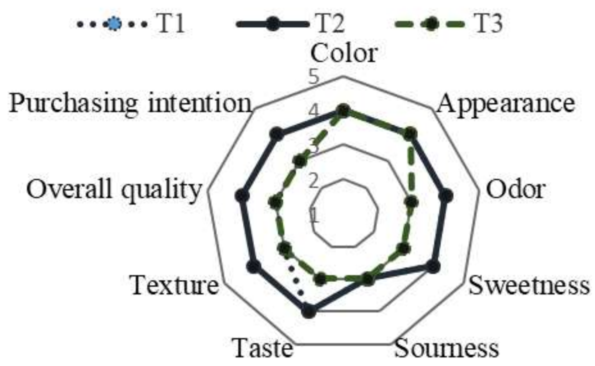

Figure 1: Mean scores obtained for sensory attributes of oat incorporated drinking yogurt (T1 – 0.25 g Oat powder per 100 ml of milk, T2 – 0.5 g Oat powder per 100 ml of milk, and T3- 1.0 g Oat powder per 100 ml of milk)

The purpose of the second sensory evaluation was to compare the oat drinking yogurt selected from the first sensory evaluation to commercial yogurt. Color, appearance, taste, texture, overall quality, purchasing intention, odor, sweetness, and sourness did not differ significantly between the selected oat drinking yogurt and commercial yogurt (Figure 2).

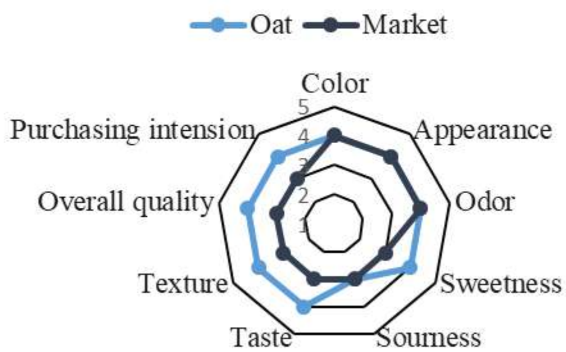

Figure 2: Mean scores obtained for sensory attributes of oat drinking yogurt T2 (selected among T1, T2, and T3) and commercial drinking yogurt.

Results of the second sensory evaluation reveal that incorporation of oat into drinking yogurt does not affect the sensory attributes and consumer preference of the product. Thus, oat incorporated drinking yogurt can be developed as a substitute for commercial drinking yogurt products which are available in the market.

3.2 Proximate analysis of oat drinking yogurt

Results of proximate analysis of oat drinking yogurt and commercial drinking yogurt are given in Table 2.

Table 2: Variation of proximate parameters between oat drinking yogurt and commercial drinking yogurt

Proximate component	Commercial drinking yogurt	Oat drinking yogurt
MC %	80.56±1.20[a]	78.13±0.80[b]
TS %	21.05±2.30[b]	26.10±2.50[a]
Ash %	0.33±1.10[b]	0.35±2.00[a]
Crude Protein %	3.06±0.10[b]	3.30±0.10[a]
Crude Fat %	3.10±0.30[b]	3.43±0.50[a]
SNF %	21.73±1.00[b]	26.08±0.60[a]
Crude Fiber %	0.00±0.00[b]	0.05±0.05[a]
Carbohydrate %	12.95[b]	14.74[a]
Energy (kcal/100 g)	91.94[b]	103.03[a]

The same letter in each row represents values not significantly different from each other ($p < 0.05$)

MC – Moisture content, TS – Total solid content, SNF – Solid Non-Fat content

The moisture content, total solid content, protein content, fat content, solid-non-fat content, fiber content, carbohydrate content, and energy content of the two drinking yogurt samples differed significantly ($P<0.05$). The addition of oat powder improves the solid content of oat yogurt, resulting in lower moisture content and higher TS and ash percentages.

Oat drinking yogurt recorded a protein content of 3.3 %. According to the CODEX alimentarius [12], yogurt should have a minimum protein value of 2.7 %. Thus, oat drinking yogurt has an appropriate protein content. The high protein content of the oat drinking yogurt developed in this study is due to the incorporation of oat which is a protein-rich cereal in the yogurt [13].

There was a significant difference in the fat content between the two drinking yogurt samples ($P< 0.05$). The higher fat content of oat drinking yogurt is attributable to the high fat content of oat grains [13]. Yogurt should have a maximum fat content of 15%, according to the CODEX alimentarius [12]. Yogurt should have a minimum fat content of 3%, according to the SLS guideline [10]. Thus, the fat percentage of oat drinking yogurt (3.43 %) is appropriate.

There was a substantial variation in the solid-non-fat (SNF) composition of the two drinking yogurt samples. These findings suggest that the addition of oats increased the SNF content. Lactose, protein, and mineral materials make up the majority of SNF [14]. SNF concentration in yogurt should be at least 8.0 % [10]. Accordingly, oat drinking yogurt contains an adequate amount of SNF. The high protein content of oats can have a direct impact on the treated yogurt's SNF value.

Due to the lack of fiber in commercial drinking yogurt, the fiber content of the two yogurt samples was also substantially different ($P< 0.05$). Oat is a high-fiber cereal [13]. Oat yogurt had a fiber value of 0.05 %. Fiber is one of the most important dietary components for human health, hence this is the product's most advantageous feature. The carbohydrate content of oat drinking yogurt was 14.74 %, while it was 12.95 % in commercial drinking yogurt. Lactose is the most common sugar in yogurt [14], accounting for a large portion of the carbohydrate content. Nonetheless, all carbohydrates, fats, and proteins serve as the primary energy sources.

Commercial drinking yogurt had an energy value of 91.94 kcal/100 g, while oat drinking yogurt had an energy value of 103.03 kcal/100 g. The higher protein and fat content of oat drinking yogurt contributes to its higher calorie value. This result demonstrates that higher energy can be obtained by consuming oat drinking yogurt than by consuming commercial drinking yogurt. As a result, this is better suited as a wonderful ready-to-drink morning beverage for people of all ages [13].

3.3 Shelf-life evaluation of oat drinking yogurt

3.3.1 Physicochemical properties

The variation of physicochemical properties with time is given in Table 3. There was a considerable variation in pH, TA, and TSS over time. The increase in lactic acid generation by lactic acid bacteria causes a decrease in pH and an increase in TA [15]. Favorably, the titratable acidity (TA) and pH levels were within acceptable limits for 21 days [10]. The TSS of oat drinking yogurt increased over time, as measured by Brix percent readings. This discrepancy could be due to the removal of water during the fermentation process.

Table 3: Variation of physicochemical properties of oat drinking yogurt stored under refrigerated temperature (4 °C) with time

Time period (Days)	pH	TSS%	TA%
1	4.62 ± 0.0^{a}	31.5 ± 0.5^{f}	0.72 ± 0.0^{d}
3	4.55 ± 0.0^{b}	33.83 ± 0.2^{e}	0.78 ± 0.0^{cd}
6	4.50 ± 0.0^{c}	34.4 ± 0.1^{de}	0.85 ± 0.0^{bc}
9	4.45 ± 0.1^{d}	34.8 ± 0.2^{d}	0.9 ± 0.0^{b}
12	4.41 ± 0.0^{e}	34.83 ± 0.2^{d}	1.04 ± 0.0^{a}
15	4.38 ± 0.1^{f}	36.5 ± 0.3^{c}	1.05 ± 0.0^{a}
18	4.29 ± 0.0^{g}	38.16 ± 0.7^{b}	1.08 ± 0.0^{a}
21	4.18 ± 0.0^{h}	39.16 ± 0.7^{a}	1.08 ± 0.0^{a}

The same letter in each column represents values not significantly different from each other ($p < 0.05$)

TSS – Total Soluble Solids, TA – Titratable Acidity

3.3.2 Microbiological assessment of oat drinking yogurt

Bacterial colony count and yeast and mold count both increased significantly over time (Table 4). Nevertheless, the bacterial colony count was acceptable, according to SLS 824 (1989) up to 21 days. According to SLS 824 [10], the yeast count exceeded the maximum colony count in the third week. This means that oat yogurt can be consumed for up to 14 days from the date of manufacture at this preservative level (300 ppm). According to Sri Lanka's Food and Food Additives Laws and Regulations [16], potassium sorbate level can be raised up to 1000 ppm.

Table 4: Variation of bacterial colony count and yeast and mold count of oat drinking yogurt with time

Time period (Day)	Bacterial count (log cfu/g)	Yeast and mold count (log cfu/g)
1	6.91^{d}	–
7	7.55^{c}	2.19^{c}
14	7.85^{b}	2.64^{b}
21	8.26^{a}	3.42^{a}

The same letter in each column represents values not significantly different from each other ($p < 0.05$)

CONCLUSION

With an oat powder level of 0.5 g per 100 ml of milk, a consumer preferable oat incorporated drinking yogurt can be developed which is competitive with commercially available drinking yogurt. Because oat powder acts as a stabilizer, no gelatin is required. According to the sensory attributes considered in this study, this product is similar to commercial drinking yogurt. Favorably, this product offers little high levels of protein, fat, and energy than commercial product. During 21 days, the pH, TSS, and TA fluctuation of the produced oat drinking yogurt remained below acceptable limits. This product can be kept at 4°C for up to 14 days during which it is microbiologically safe to drink. The findings can be used to further enhance oat drinking yogurt and bring it to the Sri Lankan dairy industry for people of all ages and to serve as an effective ready-to-drink beverage with functional properties.

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