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Quality Estimation of Probiotic Sesame Varieties Beverages

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Abstract

This study aimed to evaluate the physical - chemical properties of four different types of sesame: white sesame (WS), Shandawil 3 (SS -3), Suhagi 1 (HS - 1), a modern variety, and black sesame (BS). it assessed the suitability of these varieties for preparationhealthy probiotic beverages using a Lactobacillus strain and sesame beverage. The acceptability of the product was evaluated over a 15- days storage period. The results showed that the Suhagi 1 (HS- 1) had the highest seed weight per thousand seeds. White sesame (WS) and Chandawil 3 (SS- 3) exhibited a significant increase in appearance density. The bulk density of white sesame was significantly decreased compared to other varieties. Seed porosity ranged from 40.38 to 60.28%, and thewhite sesame having the highest porosity andthe black sesame having the lowest porosity. The chemical composition of different sesame varieties varied in terms of oil content (42.49 to 46.85%), protein (17.0 to 26.65%), ash (3.5 to 5.6%), and nitrogen-free extract (NEF) (21.25 to 27.15%). Black sesame had the highest potassium, phosphorus, and iron content, while Suhagi 1 had the highest zinc. Furthermore, sesame seeds possess a wealth of phenolic compounds and flavonoids, giving them natural antioxidant properties. The antioxidant activity of these seeds is particularly enhanced by the presence of a distinct brown pigment found in black sesame seeds. The proportion of saturated fatty acids ranged from 16.54 to 16.7% while unsaturated fatty acids ranged from 83.46% to 84.31% across the four sesame cultivars. Sohagy1 contains the highest percentage of monounsaturated fatty acids at 44.01%. Fermented black sesame beverage had higher solids, ash, fat, and protein levels. Sohagy-1 & Black sesame beverage showed favourablemicrobial quality and a high nutritional content, making it a valuable option for fermented beverages.

Keywords: Physicochemical; Antioxidant; antibacterial; probiotic sesame beverages

1. Introduction

Functional foods are defined as food items of plants and animal origins that contain certain strains of microorganisms, which contribute to their health benefits by physiologically providing active compounds. These compounds assist in minimizing the risk of developing chronic diseases [1]. Recent efforts have focused on fermenting vegan beverages as milk substitutes using various probiotic bacteria strains to enhance their health value [2]. Sesame *(Sesamum indicum, L.*) is considered the oldest oilseed crop and is economically important. It belongs to the Pedaliaceae family, and this crop is generally cultivated in tropical regions [3]. Sesame (*Sesamum indicum L.*) is an ancient and important oleaginous crop that is mainly grown in the tropical and subtropical regions of Asia, Africa and South America [4]. The total world sesame production was about 3.54 million tons, grown on 7.42 million hectares [5]. In 2012, the production reached 4,441,620 tons, covering 7,952,407 hectares with an average yield of 558.5kg/ha. From 2012 to 2016, The global production of sesame seeds is about 5 to 6 million tons per year in (2017). World sesame production has known a boom with a production of 12.22 million tons [6] and renowned for its unique chemical composition. It contains oil (50–60%), protein (18–25%), fiber (11.8%), vitamin B1, vitamin E (α, γ, δ-tocopherol), as well as essential minerals and dietary fiber.Sesame oil is particularly noteworthy due to its high content of fatty acids, including gamma-tocopherol, sesaminol, sesamin,

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oleic acid, linoleic acid, stearidonic acid, and palmitoleic acid [7]. Additionally, sesame oil possesses antimicrobial and antioxidant properties [8,9]. Sesame is utilized in various food preparations and finds extensive use in industries related to medicine, nutrition, and cosmetics [10,11]. It is known for its immune-strengthening properties, and its major lignan constituent, sesamin, exhibits antihypertensive, cholesterol-lowering, lipid-lowering, and anti-cancer activities [12]. Sesame seeds also contain lignans, such as sesameol and sesamolin, which contribute to cholesterol reduction, blood pressure regulation, liver protection against oxidative damage, and increased vitamin E levels in humans [13,14,15,16].

Probiotics are defined as selected viable microorganisms used in dietary products, which positively impact consumer health when consumed in appropriate amounts [17,18].Different probiotics have been shown to exhibit certain health benefits common to most or all probiotic species known as ‘‘core benefits’’ includes regulation of intestinal transit, normalization of perturbed microbiota, turnover of enterocytes, competitive exclusion of pathogens, colonization resistance, and short-chain fatty acid production. Other health benefits are probiotic strain specific this includes neurological effects, immunological effects, endocrinological effects, and the production of bioactives[19]. Lactobacilli, a well-known group of beneficial bacteria, are used as probiotics and serve as starter cultures in the production of fermented milk products worldwide. The development of probiotic products necessitates specific characteristics to ensure the delivery of health benefits [20]. According to FAO/WHO guidelines, probiotic products must contain a minimum count of 10^6CFUper 1ml throughout the entire storage period until the end of their shelf life [21]. Fermentation is a simple process that extends the shelf life and improves the organoleptic features of food products [22]. Fermented dairy products are generally considered microbiologically safe due to their low pH (below 4.5), inhibiting the growth of most microorganisms [23,24]. In previous studies, sesame milk, a dairy substitute, was successfully developed [2].Thisstudy aims to evaluate the physicochemicalproperties of different sesamevarieties, particularity the newly introduced, Sohage-1and compare them with existing varieties such white, (Ws), shandwil3(Hs-3) and black sesame. Moreover,physicochemical characteristics of different sesame seed milk the production of healthy probiotic beverages, incorporating select lactobacilli were determined. Additionally, the organoleptic and microbiological of non-traditional products needs to be assessed for 15 daysstorage period compared with fermented cow`s milk beverages were evaluated to detect the best treatment.

2. Materials and Methods

2.1 Materials:

2.1.1. Plant materials

Four varieties of sesame seeds *(Sesamum indicum L.)* were used in the study: White Sesame (WS) purchased from a local market in Giza Governorate, Egypt; Shandwil3 (SS-3) and Sohagy1 (HS-1), new varieties were obtained from the Oil Seeds Department, Field Crops Institute Research, Agricultural Research Center, Egypt, during the summer season of 2023; and Black Sesame (BS) grown in the Gizan area of Saudi Arabia. The sesame seeds were manually cleaned to remove foreign matter such as stones, straws, and dirt. They were then soaked and used to prepare sesame milk. Fresh cow milk was obtained from the Industrial Dairy Technology Unit, Animal Production Research Institute. *Lactobacillus delbrueckiisubsp. bulgaricus* (LB) (NCDC-253), *Streptococcus thermophilus* (ST) (NCDC-199) were procured from National Dairy Research Institute, Giza, Egypt.Vitrac strawberry syrup was acquired from Carrefour Egypt and used in the experiment.

2.1. 2. Preparation of probiotic sesame Beverages

2.1.2.1. Sesame beverage Preparation:

One litter of cow's milk and Sesame beverageblend was prepared using different varieties of sesame seedsby using one litter for each variety, following the procedure outlined by [2].sesame beverage was prepared by using a 14% initial concentration of sesame seeds to water ratio and was subsequently heated to 90 °C for 15 minutes and then subsequentlycooled to 37 °C.

2.1.2.2. Preparation of starter and mother culture:

Freeze dried bacterial cultures namely, *Lactobacillus delbrueckiisubsp. Bulgaricus* (LB) (NCDC-253), *Streptococcus thermophilus* (ST) (NCDC-199)were used.Fresh and sesame beverageobtained from each variety was collected and filled into presterilized 100 ml sesame milk per test tube, these test tubes were used to prepare the starter culture.The test tubes were heat treated at 90 °C for 15 minandimmediate cooling at 37 °C. followed by immediate cooling at 37 °C. The milk was inoculated with a culture combination (ST and LB at the ratio of 1:1 at 2% v/v) to prepare the probiotic cultures. Which were subsequently refrigerated at 4°C.

2.1.2.3. Preparation of different probiotic sesame beverages.

The probiotic culture was added at the level of 2% v/v to cow and different sesame beverages.until coagulation occurred. After coagulation, 1% Vitrac strawberry syrup was added to the mixture as a sweetener, flavoring, and coloring agent. This addition was made to enhance the color, texture, and taste of the fermented beverage. The product was then stored under refrigeration at 4°C. Samples were collected from each treatment at zero time (fresh), after 7 days, and after 15 days for studying the microbiological, and organoleptic properties.

2.2. Physical properties of seeds

2.2.1. Determination of 1000 seed mass

The mass of 1000 seeds were determined using an electronic digital balance (Mitutoyo Digital Scale) with an accuracy of 0.001g. A random sample size of 100 seeds was selected and weighed using the digital balance. The obtained mass of the 100seeds sample was then multiplied by 10 to calculate the mass of 1000 seeds. This method of seed mass determination is consistent with the approach reported by [25]. To ensure accuracy and minimize errors, the readings were repeated to five replications. This replication process helps to reduce variability and enhance the reliability of the obtained measurements.

2.2.2. Determination of basic dimensions

For the determination of the basic dimensions of the seeds (length, width, and thickness), a Vernier Caliper (150 MM × 0.02MM 6" × 1/1000") with an accuracy of 0.001mm was used. The Vernier Caliper was manufactured in China. This measurement method aligns with similar approaches reported [26].

The seeds were measured for their length, width, and thickness using the Vernier Caliper. The arithmetic and geometric means of these three basic dimensions were calculated. This calculation was performed using Equation No.1 and Equation No.2, as suggested by [27].

$$Da = \frac{L+W+T}{3} \quad \text{Equation No.1}$$

$$Dg = (L \times W \times T)^{(1/3)} \quad \text{No.2}$$

In these equations, Da represents the arithmetic mean (mm), Dg represents the geometric mean diameter (mm), L denotes the length (mm), W signifies the width (mm), and T represents the thickness (mm).

Additionally, the aspect ratio (Ra) was calculated using Equation No. 3

$$Ra = L / W \quad \text{Equation No .3}$$

The aspect ratio (Ra) provides information about the ratio between the length and width of the seeds, which can be an important characteristic for analyzing seed shape and morphology.

2.2.3. Determination of surface area

The determination of surface area is a crucial aspect when considering seeds, as it aids designers in estimating the size of the hopper, processing chamber, and chute. To calculate the surface area, an analogy is made with a sphere of a geometric mean diameter. This approach is described by Equation (No.4), as referenced by [28].

$$S = \pi\, Dg \quad \text{Equation No .4}$$

Where, S (mm2) represents surface area and Dg stands for geometric mean diameter (mm) respectively

2.2.4. The Sphericity

The Sphericity is defined as the ratio of the surface area of the sphere having the same volume as that of the seed. Likewise, it is regarded as the degree of closeness of seed to a sphere. Furthermore, it also describes the rolling ability of seed during processing therefore it is a function of the basic dimensions (length, width and thickness) and can be calculated using the formula in Equation No.5 [29].

$$Ø = ((L * W * T)^{(1/3)}) / L \quad \text{Equation No.5}$$

Where Ø is Sphericity, L is the length, W is the width of the seed and T represents the seed thickness.

2.2.5. The bulk density

The bulk density (ρb)), as in Equation No.6, is the ratio of the mass (Wb) of seed samples to its total volume (Vb). The average bulk density was determined by filling 100 ml container with seeds from a height of 70: 90mm at a constant rate and reweighting the content with no compaction on the seeds. The volume of the beaker was calculated using Equation NO.7 and the bulk density as shown in Equations NO.6 by [26]. and it was repeated for ten replications. Furthermore, increase in mass of the seed increases the bulk density of the seed. Some researchers have presented negative trends on some seeds while some reported otherwise. It is therefore used in determination of porosity and in estimation of food fungal attack rate.

$$\rho b = Wb / Vb \quad \text{Equation No.6}$$

$$Vb = \pi r2h \quad \text{Equation No.7}$$

Where, ρb is Bulk density, Wb is mass, Vb represents volume, r is the radius and h stand as height respectively.

2.2.6. The true density:

The water displacement method was used to determine the true density of the seeds which has been defined as the ratio of mass of the seeds to the true volume of displaced water [30].

The true density was obtained by measuring 10g of seeds and filling into a 100ml of distilled water, thus the difference in liquid displacement was taken in 10 replications and average recorded.

2.2.7. Porosity:

The porosity is defined as the ratio of empty space of seeds to its total volume. This was calculated from the measured values of densities (Bulk and True) using the relationship given in Equation No.8 [31].

$$\varepsilon = (1- \rho b/\rho t)100 \quad \text{Equation No.8}$$

Where ε the porosity, ρb is the bulk density and ρt is the true or grain density.

2.2.8. Color measurement

The color of different varieties of sesame was assessed through visual evaluation as well as colorimetric measurements. The colorimetric measurements were conducted in triplicate using a colorimeter (CR-10, Konica Minolta Sensing Inc., Japan) following the method described by [32]. The color parameters recorded were *L** for lightness (ranging from 0 for black to 100 for white), *a*a* for greenness (-a* indicates greenness, +a* indicates redness), and b* for blueness (-b* indicates blueness, +b* indicates yellowness)

2.2.9. The pH value

The pH value was measured by using a pocket pH meter model (IQ Scientific USA, Model IQ 125).

2.2.10. Titratable acidity (T.A)

T.A was determined and calculated according to the methodology described by [33].

2.3. **Chemical composition**

(Moisture, crude fat, ash and protein were determined according to[34], Total carbohydrate content was estimated as nitrogen-free extract (NFE), which was calculated by deference using the equation: NFE = 100 - (fat + protein + ash) [Equation No.9]

2.4. Determination of minerals

Microwave digestion using a Multiwave Go Plus system was employed samples for mineral analysis potassium (K), sodium (Na), calcium (Ca), zinc (Zn), phosphour (P)and iron (Fe). The digestion process was followed by quantification of the minerals using microwave plasma Atomic Emission Spectroscopy (MP-AES) via a model 4210 instrument manufactured by Agilent in Malaysia. The methodology followed the guidelines [34].

2.5. Phytochemical analysis

The antioxidant activity was determined using the free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH) as a reagent, following the method described by [35].Total phenols were measured calorimetrically using Folin-Ciocalteu reagent, with results expressed as Gallic acid equivalents, according to [36].

Total flavonoid content was determined as Quercetin equivalents following the method outlined by [37].

2.6. Fattyacids

The samples were analyzed for free fatty acids using gas chromatography (GC) based on the protocol specified in [38].To facilitate analysis, the fatty acids were converted into methyl esters.

2.7. Sensory evaluation

Sensory evaluation was conducted by a panel of 24 experienced judges with backgrounds in food technology. In Giza, Egypt, at the Agricultural Research Center. Several quality attributes were awarded, including flavor (45 points), body and texture (30 points), appearance (15 points) and color (10 points) according to the guidelines provided by [39].

2.8. Microbiological analysis

Microbiological analysis was performed to determine the total bacteria count, total yeast, mold count and coliform group count. The methods specified by [40].

2.9.**Statistical Analysis:**

The mean value of three measurements was taken for each parameter assessed in the study. Data evaluated statistically using a variance analysis (ANOVA) and the Duncan's new multiple range test. All the statistical analysis was done using SPSS version 17.0 (Chicago, USA). The level of significance was set at $P< 0.05$.[41].

3. Results and Discussion

3.1. Physical properties of sesame seeds

The physical properties of various sesame seeds varieties are presented in Table 1, which includes visual color, weight of thousands of seeds, bulk and true density, porosity (ε)%, diameters Da and DG, sphericity percentage (Ø%) surface area (S), and color measurement. The study found significant differences in the weight of thousands of seeds between the sohagy1 (HS 1) variety and the other sesame varieties, with sohagy1 (HS 1) having the highest weight of 3.23g/1000 seeds. While white sesame (WS) and Shandwil 3 (SS 3) varieties did not show any significant difference in their weight of thousands of seeds 2.85 g and 2.81 g, respectively. On the other hand, the weight of black sesame (BS) was the lowest, at 2.26g per 1000 seeds. These findings align with the range reported by [42]which was 2.0 to 3.5g per 1000 seeds and by [43] which was 2.76 to 3.96g per 1000 seeds for 12 cultivated sesame genotypes. However, results may vary based on the variety and cultural conditions. In terms of true and bulk density, white sesame (WS) and Shendwil 3 (SS 3) varieties showed a significant increase in appearance density (1.41 and 1.38g/ml^3), respectively), while Sohagy 1 (HS1) and black sesame varieties demonstrated a significant decrease (1.1 and 1.04g/ml^3) respectively. Additionally, the bulk density was significantly decreased in the white sesame variety (0.56g/ml^3)compared to other varieties. The findings are consistent with [44], who found that the true density of Nigerian sesame seeds was (1224g/ ml^3). Additionally, [45] reported that the true density of sesame seed varieties ranged from 1190.66 to 1215.62g/ ml^3),depending on seed separation or cleaning processes. The table presents the average axial dimensions of the seeds (length, width, and thickness). Significant increases of length were observed in the White Sesame (WS), Shendwil 3 (SS3), and Sohagy 1 sesame (HS1) varieties, while a significant decrease (2.93 mm) was found in the black sesame variety. A notable increase (1.86mm) was found in the width of the black sesame variety compared to the other three varieties (White (1.63mm), Black (1.69mm), and Shaggy 1 (1.63mm). No significant differences were found in the thickness among all varieties, ranging from 0.132 to 0.17mm. No significant differences were found in terms of Dg, Da, and the surface area among all sesame varieties. However, significant differences were found in the sphericity percentage, ranging from 26% to 33% of seeds. Higher sphericity values indicate a more spherical shape of the grains, which can impact other physical properties of the grains and subsequently affect harvest, post-harvest, and grain storage operations [46]. The porosity of the grain mass represents the space between the grains of a particular cultivar in a rest state. It is directly linked to the efficiency of machines, equipment, and structures during harvesting, post-harvesting, and storage phases [47]. Determining the porosity of the grains is essential, as smaller or larger intergranular voids may indicate greater or lesser resistance offered to the passage of air through the product mass, affecting the behaviour, uniformity, and efficiency of drying or aeration operations [48]. The porosity ranged from 40.38% to 60.28%, with white sesame having the highest porosity value and the black sesame variety having the lowest value. The color measurement parameters for sesame seeds are summarized in Table 1 and Fig. 1. The lightness (*L**) values showed significant differences among the sesame varieties, with the black sesame variety being the darkest (51.47±1.15) and the white sesame variety being the lightest (81.83±0.47). In terms of the redness parameter (*a**), the Sohagy 1 variety had the highest value (5.3±0.26), followed by the black sesame and Shendwil 3 (SS3) varieties. Conversely, the white sesame variety recorded a significant decrease (0.38±0.40) in redness (*a**). There were no significant differences in the (*b**)color parameter among white sesame, Shendwil 3, and Sohagy 1, while the black sesame variety showed a significant decrease (7.03±1.26) in the same color parameter. In summary, the color of the sesame seeds varied from white, light brown, brown, and black for the white sesame, Shendwil-3, Sohagy -1, and black sesame varieties, respectively. These results align with previous reports by [49, 50]. The color of sesame seeds can vary, including red, white, black, and yellow (Fig. 1), depending on the different varieties. The seeds which may be whitish to brown or black depending on the variety [51]. This variation may be due to genotypic effects. Seed color is an important characteristic in sesame, as it is linked to the biochemical properties, antioxidant content, seed activity, and disease resistance in sesame crops [52]. Additionally, black sesame seeds are reported to have more health benefits compared to white sesame seeds [53].The seed characteristics or physical properties of sesame seeds vary and this variation may likely be as a result of variability in genotypic effects[50]. The physical properties i.e length, width, thickness, geometric mean diameter, sphericity and surface area of the two common local sesame seeds varieties in Nigeria varied from 2.9–3.2mm, 1.9–2.1mm, 0.85–0.91mm, 1.59–1.72mm, 0.575–0.58mm and 7.05-10.2mm respectively[44].

Table (1): Physical properties of sesame seeds varieties

Parameters	Sesame Varieties			
	WS	SS	HS	BS
Color (visual)	Dull white	Brown	Brown dark	Black
Length (mm)	$3.3^{a} \pm 0.10$	$3.26^{a} \pm 0.23$	$3.36^{a} \pm 0.05$	$2.93^{b} \pm 0.11$
Width (mm)	$1.63^{b} \pm 0.15$	$1.65^{b} \pm 0.15$	$1.63^{b} \pm 0.11$	$1.86^{a} \pm 0.11$
Thickness (mm)	$0.167^{a} \pm 0.01$	$0.132^{a} \pm 0.01$	$0.135^{a} \pm 0.03$	$0.171^{a} \pm 0.01$
Ra=L/W(mm)	$2.02^{a} \pm 0.02$	$1.97^{a} \pm 0.07$	$2.06^{a} \pm 0.04$	$1.57^{b} \pm 0.07$
1000 seeds weight (g)	$2.85^{b} \pm 0.06$	$2.81^{b} \pm 0.17$	$3.23^{a} \pm 0.03$	$2.26^{c} \pm 0.01$
Volume (ml)	$2.02^{b} \pm 0.20$	$2.03^{b} \pm 0.03$	$2.92^{a} \pm 0.04$	$2.16^{c} \pm 0.08$
Bulk denticity ρb (g/ml)	$0.56^{b} \pm 0.01$	$0.62^{a} \pm 0.01$	$0.625^{a} \pm 0.01$	$0.62^{a} \pm 0.004$
appearance denticity (g/ml³)	$1.41^{a} \pm 0.02$	$1.38^{a} \pm 0.01$	$1.1^{b} \pm 0.01$	$.041^{b} \pm 0.02$
Porosity% (ε)	$60.28^{a} \pm 0.19$	$55^{b} \pm 0.20$	$43.16^{c} \pm 0.2$	$40.38^{d} \pm 0.04$
Da (mm)	$1.69^{a} \pm 0.12$	$1.68^{a} \pm 0.01$	$1.7^{a} \pm 0.057$	$1.65^{a} \pm 0.05$
DG (mm)	$0.96^{a} \pm 0.02$	$0.89^{a} \pm 0.01$	$0.90^{a} \pm 0.09$	$0.97^{a} \pm 0.37$
sphericity (Ø)%	$29^{b} \pm 0.01$	$27^{b} \pm 0.01$	$26^{b} \pm 0.05$	$33^{a} \pm 0.36$
surface area (S) (mm²)	$2.9^{a} \pm 0.23$	$2.5^{a} \pm 0.12$	$2.56^{a} \pm 0.15$	$2.95^{a} \pm 0.50$
Color parameters measurements				
L*	$81.83^{a} \pm 0.47$	$71.09^{b} \pm 1.16$	$64.01^{c} \pm 1.99$	$51.47^{d} \pm 1.15$
a*	$0.38^{d} \pm 0.40$	$2.96^{c} \pm 0.37$	$5.3^{a} \pm 0.26$	$4.73^{b} \pm 0.28$
b*	$16.9^{a} \pm 0.15$	$16.2^{a} \pm 1.36$	$16.08^{a} \pm 0.57$	$7.03^{b} \pm 1.26$

Where: - WS, white verity SS shandwil3 verity HS, sohagy1 verity BS, black verity
*L** = lightness color score, *a** = redness color score, *b** = yellowness color score
*Each value in the same row followed by the same letter isn't significantly different at ($p< 0.05$)

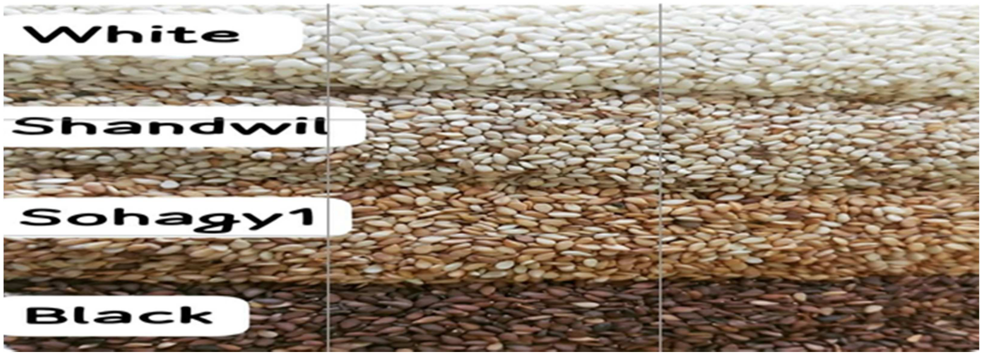


Figure 1: Various sesame seeds varieties

3.2. Chemical composition of sesame seeds.

The nutritional composition of various sesame seeds varieties was analysed, and the results are presented in Table 2. The composition includes percentages of oil, protein, ash, and nitrogen-free extract (NEF). The oil content ranged from 42.49% to 46.85%, protein content ranged from 17.0% to 26.65%, ash content ranged from 3.5% to 5.6%, and nitrogen-free extract (NEF) content ranged from 26.96 % to 31.82%. Among the sesame seed varieties, the oil content does not exhibit significant differences, except for white sesame, which has a significantly lower oil content of 42.94%. On the other hand, the protein content significantly increases to 26.6% in certain varieties, while black sesame showed a significant decrease to 17.0%. The highest concentration of ash content was observed in black sesame at 5.6%, followed by shendwil-3 at 5.1%. White sesame showed a significant decrease in nitrogen-free extract NFE content to 26.96% compared to other varieties. These findings align with the study conducted by [54]**,** which reported fat, protein, and ash content ranging from 43.05% to 43.1%, 19.17% to 21.61%, and 3.3% to 4.51%, respectively, in white, brown, and black sesame seeds. Additionally, the protein content range NFE was 18%–25%as reported by [55]who agrees with these findings. [56] reported that the oil content was vary from 43.4% to 58.8% among 42 strains of sesame, with the highest oil content found in white-seeded strains. [57] reported oil content in Saudi and Indian sesame seeds ranging from 43.2% to 54.0%. On the other hand, the results showed that sesame seeds possess an important mineral composition, as calcium showed the highest concentrations, which ranged from 1219 to 1600mg/100grams. Followed by potassium, with concentrations ranging from 480.79to 663.23mg/100grams, then phosphorus, with concentrations ranging from 419.67 to 545.20mg/100grams. These results are consistent with a previous study by [58]. Another study conducted by [59], showed that the mineral content of white sesame seeds was presented, with calcium (Ca) reported 445.02mg/100g, phosphorus (P) 428.53mg/100g, magnesium (Mg) 365.95mg/100g, zinc (Zn) 2.72 ± 0.25 mg/100g, and iron (Fe) 4.98mg/100g. Also, [60] revealed that levels of calcium, iron, zinc, and phosphorus ranged from 1,174 to 1,664, from 13.9 to 15.04, from 7.77 to 8.59, and from 568 to 754 mg, respectively, for white, brown, and black sesame varieties. Regarding the Shindawil-3 cultivar, the values for potassium and calcium (610.981 and 1600, respectively) are very similar to those reported by [61], who presented a mineral composition of 0.16 g/100 g for phosphorus (P), and 0.77g/100g for potassium (K), 0.35g/100g for sodium (Na), 1.56g/100g for magnesium (Mg), and 1.40g/100g for calcium (Ca). These results are also consistent with the findings of [62]**,** who studied the mineral content of sesame seeds separately for black and white varieties and recorded the values in mg/100g. These results include sodium (72–78), potassium (374–382), calcium (1200–1228), magnesium (185–178), iron (10.4–10.6), zinc (3.6–3.8), and phosphorus (580–598). Significant differences were found between all sesame varieties with regard to sodium levels. Conversely, the black sesame cultivar showed a significant increase in the levels of sodium (74.448mg/100g),potassium (663.23mg/100g), phosphorus (528.55mg/100g), and iron (11.372mg/100g). Sohagy1 cultivar had the highest zinc concentration (8.284mg/100g). In addition, phosphorus and calcium Levels was significantly increased in white sesame (545.2mg/100g) and Shadwell3 (1600mg/100g) cultivars, respectively. Noticeable differences in mineral compositions between sesame seeds can be attributed to genetic differences, growing conditions, soil characteristics, and geographic locations. Different sesame varieties, different climates, soil types and agricultural practices contribute to differences in mineral content. Furthermore, factors such as timing of harvest, storage conditions, and methods used for mineral analysis can influence observed differences. In general, a combination of genetic, environmental, and analytical factors affects the mineral content of sesame seeds.

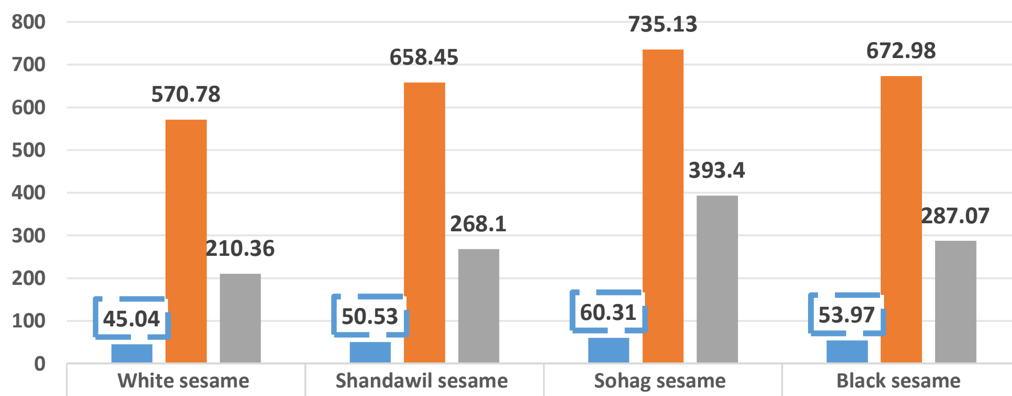
Table (2): Chemical composition of different varieties of sesame seeds on dry weight

Sesame varieties	WS	SS	HS	BS
Macronutrients (g/100g)				
Oil content	42.94 ^{b}± 0.20	44.54 ^{a} ±0.52	44.52 ^{a} ±0.52	46.85 ^{a} ±0.68
Protein content	26.6^{a}± 0.20	18.54^{b}± 0.36	20.9^{c} ± 0.52	17.0^{d}± 0.01
Ash	3.5^{bc} ±0.10	5.1 ^{ab} ± 0.2	3.83^{bc} ± 0.14	5.6^{a} ±1.5
Nitrogen free extract (N. F. E)	26.96^{c}± 0.5	31.82^{a} ± 0.36	30.75^{b}±0.517	30.55^{b} ± 0.01
Micronutrients (mg/100 g)				
K	480.793^{d} ±0.2	610.981^{b}± 0.1	549.0^{c} ± 0.1	663.23 ^{a}± 0.73
Na	51.433 ^{c} ± 0.2	49.59^{d} ±0.2	69.464^{b}± 0.39	74.45 ^{a} ± 0.3
Ca	1297 ^{c} ± 1.9	1600 ^{a} ±1.93	1398^{b} ± 1.89	1219 ^{d} ±1.99
Zn	3.095^{c}± 0.016	7.455 ^{b} ± 0.2	8.284 ^{a} ± 0.1	3.258 ^{c} ±0.11
P	54 5.2 ^{a} ± 0.02	440.69^{b}± 0.22	4 19.67 ^{b} ±0.58	528.55^{a} ±0.25
Fe	10.175^{b}± 0.02	9.765 ^{c} ± 0.2	10.138 ^{b} ±0.1	11.37^{a} ±0.15

Where: WS, white verity SS shandwil3 verity HS, sohagy1 verity BS, black verity
Each value in the same row followed by the same letter isn't significantly different at ($p< 0.05$)

3.3. Antioxidant activity, total phenolic content and flavonoid content of specific sesame varieties

The proper regulation of free radicals is crucial because while they can have beneficial effects, an excessive accumulation of reactive oxygen species (ROS) can lead to oxidative stress and harm the body. To counter this, it is important to find exogenous antioxidants from natural sources that can supplement our internal defence system. Some synthetic antioxidants have been shown to scavenge free radicals, but they have also been found to have toxic effects. Therefore, there is an increasing need for safe and alternative plant-derived antioxidants [63]. Antioxidants are commonly used as food additives to enhance food stability and extend shelf life by inhibiting lipid peroxidation and protecting against oxidative damage [64]. According to [65], sesame seeds are effective in preventing the harmful effects of free radicals by donating hydrogen atoms. The high levels of phenolic compounds found in sesame seeds contribute to their antioxidant activity, making them suitable for therapeutic applications. figure (2) illustrates that the highest antioxidant activity was observed in the methanolic extract of sohag 1 sesame (60.31%), while the lowest value was found in the methanolic extract of white sesame (45.04%). The methanol extracts of black and Shandawil 3 sesame seeds exhibited inhibition percentages of 53.97% and 50.35%, respectively, indicating significant antioxidant potential. This is supported by the study of [66], who maintained that the brown pigment in the ethanolic extract plays a prominent role in the antioxidant activity of black sesame seeds, as it is responsible for many physiological functions. However, these results differ from a previous study by [65]**,** who showed a55.73% and 61.16% inhibition for ethanol extract of black and white sesame seeds, respectively. [67] stated that white and black sesame seeds could be developed as sources of natural antioxidants. A previous study by [68]. reported similar antioxidant activity in methanol extracts of sesame seeds. The percentage of inhibition in the methanol extract ranged from 41.62% to 54.24% in leaves, from 31.60% to 49.42% in seeds, and from 19.10% to 28.97% in roots. The aqueous extracts showed inhibition rates ranging from 23.95% to 35.39% in leaves, 20.48% to 37.09% in seeds, and 10.53% to 15.16% in roots. These results also support the effectiveness of sesame seeds in combating the harmful effects of free radicals by donating hydrogen atoms. Phenolic compounds, widely distributed in plants and plant products, possess antioxidant activity due to their ability to donate hydrogen atoms or electrons and form stable radicals. Flavonoids, known as primary antioxidants, also act as radical receptors and interrupt chain reactions. The position and degree of hydroxylation play a crucial role in determining the antioxidant activity of flavonoids [69]. The phenolic and flavonoid content of different sesame seeds was evaluated, and Sohag1 sesame extract showed the highest content of 735.13mg/100g gallic acid and 393.4mg/100g gallic acid, respectively. The phenolic content of methanol, ethanol, and acetone extracts was 81.72, 95.6, and 99.67µg/10µL GAEC, respectively. The flavonoid contents of the extracts were 61.2, 9.17, and 36.86µg CE1/0µL for methanol, ethanol, and acetone extracts, respectively. The presence of these abundant phenolic compounds in sesame seeds suggests that they could be responsible for the antioxidant potential of this plant [63]. In general, the antioxidant, total content of phenolic compounds and flavonoids in this study were somewhat different from those reported in previous studies. This difference can be attributed to the diversity of the species studied or the methodology used in the analysis. It has been shown that the quantity and quality of bioactive components in sesame seeds depend on environmental and physiological factors such as climate and soil type, which can affect the bioactive components of sesame seeds [70, 71].



	White sesame	Shandawil sesame	Sohag sesame	Black sesame
DPPH (%)	45.04	50.53	60.31	53.97
Total phenols	570.78	658.45	735.13	672.98
Total flavonoid	210.36	268.1	393.4	287.07

Figure 2: Antioxidant activity (%), total phenolic content (mg GA/100 g.) and flavonoid content (mg QE/100 g) of specific sesame varieties

3.4. Fatty acid content of some sesame seeds

Table (3) represents the fatty acid composition percentages of four different varieties of sesame seeds: white, shandwil 3, sohagy 1, and black sesame. The total proportion of saturated fatty acids (SFA) was determined to be 16.54, 15.69, 16.36, and 16.7% for the respective varieties. The primary saturated fatty acids identified were palmitic acid (16:0) and stearic acid (18:0). The percentages of palmitic acid were 9.55, 9.49, 9.40, and 10.05% for the aforementioned varieties, while the percentages of stearic acid were 6.08, 5.47, 6.17, and 5.13% respectively. The range for arachidic acid (20:0) fell between 0.56% and 0.69%. The total percentage of unsaturated fatty acids (USFA) in the same varieties was found to be 83.46, 84.31, 83.64 and 83.3% respectively. The primary unsaturated fatty acids observed were oleic acid (18:1) and linoleic acid (18:2). The percentages of oleic acid were 38.67, 40.50, 43.63 and 39.21% while the percentages of linoleic acid were 44.10, 43.09, 39.34 and 43.34% respectively. It is noteworthy that all types of sesame seeds exhibit high levels of unsaturated fats, which are considered healthier compared to saturated fats. Among the varieties, Suhagi sesame recorded the highest monounsaturated fat content at 44.01%, while white sesame and black sesame displayed the lowest monounsaturated fat content at 39.01% and 39.66% respectively. White and black sesame demonstrated the highest content of polyunsaturated fatty acids (PUFA) at 44.45% and 43.65% respectively in comparison to the other two varieties. The variations in fatty acid compositions across sesame seed types are relatively minor. These findings align with previous research conducted by [72], which revealed that sesame seeds are rich in polyunsaturated fatty acids, particularly omega-6 fatty acids, as well as trans fatty acids. The fatty acid composition of sesame seeds was shown to consist of 14% saturated fatty acids, 39% monounsaturated fatty acids, and 46% polyunsaturated fatty acids. [73] also reported that the primary saturated fatty acids found in Sesamum indicum L. seed oil are palmitic and stearic acids, while the primary unsaturated fatty acids are linoleic and oleic acids. Linoleic acid, an essential polyunsaturated fatty acid, holds significant nutritional value in the human diet. Determining the superior sesame seed variety based on these compositions and overall balance of fatty acids can be challenging due to their similarities. However, it is crucial to acknowledge that all varieties serve as valuable sources of unsaturated fats, which contribute to cardiovascular health and general well-being. These fats encompass both polyunsaturated fats and monounsaturated fats. *Sesamum indicum L* oil primarily comprises oleic and linoleic acids, accounting for 38.84% and 46.26% respectively. These findings are consistent with existing literature. Linoleic acid stands as a crucial polyunsaturated fatty acid in the human diet, aiding in the prevention of various cardiovascular diseases [74].Sesame seeds are utilized for their oil, owing to their abundance of beneficial fatty acids such as gamma-tocopherol, sesamin, sesaminol, and unsaturated fatty acids (e.g., linoleic acid, oleic acid, palmitoleic acid, stearidonic acid, and traces of linolenic acid) [7]. The fatty acid composition of sesame oil is primarily composed of linoleic, oleic, palmitic, and stearic acids [75].

Table 3: Fatty acid (%) composition of some sesame seeds verities

Fatty acid	**Sesame seed varieties**				
		WS	**S S-3**	**HS-1**	**BS**
Myristic	C14:0	0.02	0.02	0.02	0.82
Palmitic	C16:0	9.55	9.49	9.40	10.05
Palmitoleic	C16:1	0.14	0.17	0.16	0.18
Heptadecanoic	C17:0	0.07	0.05	0.05	.05
Heptadecenoic	C17:1	0.03	0.03	0.03	.03
Stearic	C18:0	6.08	5.47	6.17	5.13
Oleic	C18:1	38.67	40.50	43.63	39.21
Linoleic	C18:2	44.10	43.09	39.34	43.34
Linolenic	C18:3	0.35	0.31	0.29	0.31
Arachidic	C20:0	0.69	0.56	0.61	0.64
Gadoleic	C20:1	0.18	0.22	0.19	0.24
Behenic	C22:0	0.13	0.10	0.11	0.01
ΣSFA	------	16.54	15.69	16.36	16.7
ΣUSFA	--------	83.46	84.31	83.64	83.31
ΣMUFA	-------	39.01	40.91	44.01	39.66
ΣPUFA	---------	44.45	43.40	39.63	43.65

Where: WS, white verity; SS-3 shandwil verity; HS-1, sohagy verity; BS, black verity; SFA – Saturated fatty acid; USFA – Unsaturated fatty acid; MUFA – Monounsaturated fatty acid; PUFA – Poly unsaturated fatty acid

3.5. Sensory evaluation of fermented sesame beverages of different varieties.

Table 4 and Figure 3(a, b and c) display the changes in flavour, body, texture, appearance and colour of the fermented sesame beverages and the control made from cow's milk over 15days storage period. At the beginning of the storage period, white sesame and Sohgi-1 1 (FHSB-1) did not show any significant differences in sensory attributes compared to the control group, while Shendol3 and black sesame showed significant decreases in all sensory parameters. This trend continued throughout the storage period, with all sesame varieties and control treatments showing significant decreases in all sensory attributes. This may be due to pH values and antioxidants. Overall, Sohgi1 was the most acceptable variety, followed by white, black and Shendol3 beverage varieties, compared to the control treatments. However, all treatments were still acceptable to the participants. At the end of the storage period, a significant decrease was found in all different beverages, especially BS beverages. Figure 3 (a, b, c) explained the area of the radar graph for each treatmentduring the storage periods. The figures also provide an indication of the overall quality. The area-based radar graph shows that the control sample and the fermented beverage containingSohagy1 sesame obtained the highest ratings, followed by white sesame, shandwil-3 sesame, and finally the black sesame beverage which obtained the lowest ratings in all indicators. This trend continued throughout the storage period. Overall, the fermented sesame beverage Sohagy1 showed the highest level of acceptability among the other varieties. The results were consistent with the findings of [76] that sesame butter weakens milk clots, making them more susceptible to synergy. In conclusion, we recommend the use of sesame and the probiotic *Lactobacilli L.* to create a new fermented dairy product rich in nutritional value, such as antioxidants, fiber, unsaturated fatty acids, and minerals.

Table 4: Effect of storage period on the sensory evaluation of fermented Cow milk and fermented sesame beverages of different varieties

Samples	Storage period (days)	Flavor (45)	body and Texture (30)	Appearance (15)	Color (10)
FCMB	Fresh	42.60 ^{a} ±3.8	28.6 ^{a} ±2.34	14.66 ^{a} ±0.7	9.8^{a}±0.01
	7	41.59 ^{a} ± 3.7	28.2 ^{a} ±2.2	14.65 ^{a} ±0.7	9.3^{b}±0.35
	15	36.9 ^{b} ± 3.6	26 ^{b} ±2.0	13.72 ^{b} ±0.6	8.93^{cde}±0.05
FWCB	Fresh	39.99 ^{ab} ±3.6	27.27 ^{ab} ±1.92	13.95 ^{ab} ±1.22	9^{cde}±0.1
	7	36.0 ^{b} ±1.05	27.2 ^{ab} ±1.9	13.95 ^{ab} ±0.9	9.04^{bcde}±0.2
	15	31.05 ^{c} ± 2. 6	26 ^{b} ±1.92	13.67 ^{b} ±1.2	8.7^{ef}±.04
FSSB-3	Fresh	38.89 ^{ab} ±3.4	26.4 ^{b} ±1.5	13.66 ^{b} ±1.3	8.78^{def}±0.04
	7	36.98 ^{b} ±0.99	24.6 ^{c} ±1.99	13.65 ^{b} ±1.3	8.7^{ef}±.07
	15	35.1 ^{c} ±2.6	23 ^{cd} ±1.88	13.65 ^{b} ±1.2	8.5^{f}±.1
FHSB-1	Fresh	40.59 ^{a} ±3.25	27.7 ^{ab} ±1.92	14.4^{a} ±1.0	9.18^{bc}±.18
	7	39.6 ^{a} ± 3.34	27.2 ^{ab} ±2.0	14.32 ^{a} ±0.89	9.15^{bcd}±.15
	15	37.8 ^{ab} ± 3.2	25 ^{bc} ±1.99	13.74 ^{b}±1.1	8.65^{ef}±.05
FBSB	Fresh	37.44 ^{b} ±4.27	25.4 ^{c} ±2.65	12.82 ^{c} ±1.16	8.5^{f}±.1
	7	36 ^{b} ± 2.9	25.4 ^{c} ±2.9	12.82 ^{c} ±1.10	8.49^{f}±.09
	15	35.1 ^{c} ± 2.6	23.13 ^{cd} ±1.81	12.3 ^{d}±0.78	8.49f±.09

Where: FCMB,fermented cow's milk beverage; FWSB, fermented whitesesame beverage; FSSB-3 fermented shandwilsesame beverage; FHSB-1, fermented sohagy sesame beverage FBSB, fermented black sesame beverage.
Each value in the row followed by the same letter isn't significantly different at ($p< 0.05$) *

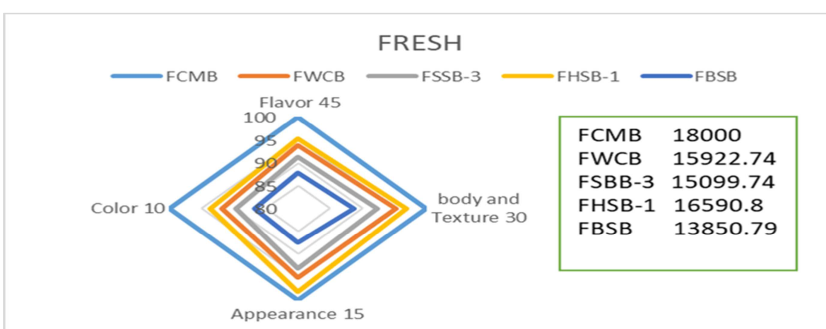


Figure 3 (a): Sensory evaluation of fermented Cow milk and fermented sesame beverages on fresh period

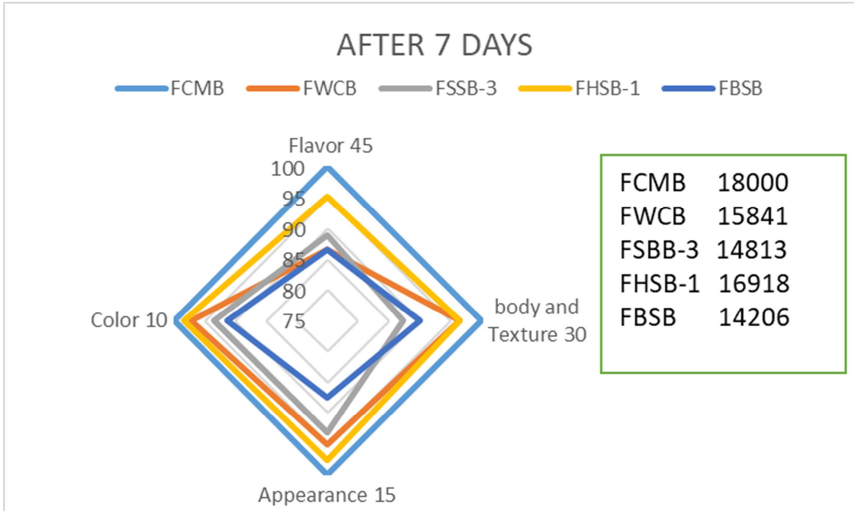


Figure 3 (b): Sensory evaluation of fermented Cow milk and fermented sesame beverages after 7 days

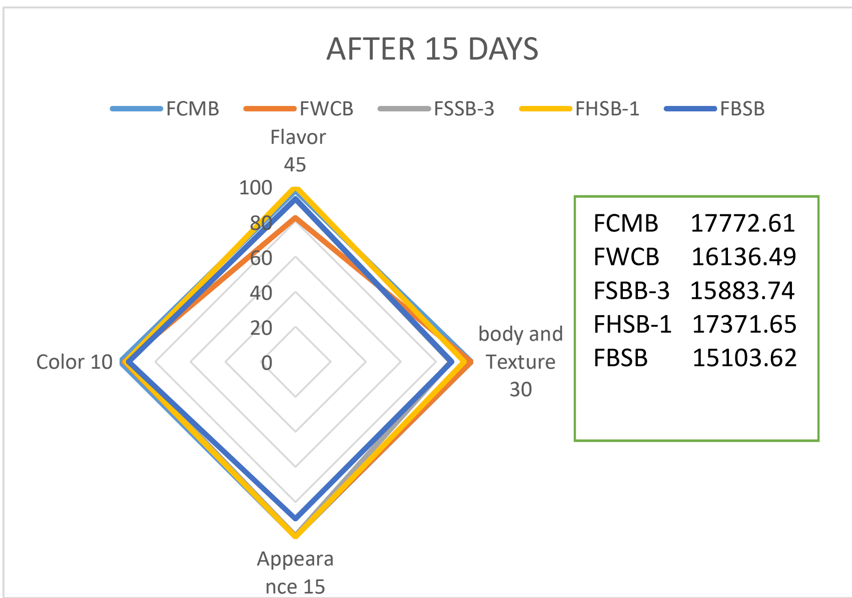


Figure 3(c): Sensory evaluation of fermented Cow milk and fermented sesame beverages after 15 days

3.6. The effect of storage period on chemical composition of Probiotic Fermented beverage of sesame seed verities.

The compositional analysis of various fermented dairy beverages, including fermented cow's milk and different types of fermented sesame milk (white, Shandwil 3, Suhagi 1 and black), was conducted and compared. The analysis focused on factors such as total solids, ash, fat, protein, and nitrogen-free extract (NFE). Fermented cow's milk was found to have total solids ranging from 19.53 to 21.75% protein ranging from 2.28 to 3.7 % ash ranging from 0.75 to 0.85% fat ranging from 3.50 to 3.60% and nitrogen-free extract (NFE) ranging from 12.80to13.80%. In comparison, white sesame beverage products exhibited total solids ranging from 19.57 to 22.47%, protein ranging from 4.0 to 2.3% ash ranging from 0.79 to 0.97% fat ranging from 6.01 to 6.02% and nitrogen-free extract (NFE) ranging from 10.44 to11.67%. Shandwil 3 sesame milk products had total solids ranging from 19.69 to 20.85% protein ranging from 3.1 to 2.2%. ash ranging from 0.8 to 0.95%. fat ranging from 6.23 to 6.24%. and nitrogen-free extract (NFE) ranging from 10.21 to 10.72% Sohagy 1 sesame beverage products showed total solids ranging from 19.16 to 19.84% protein ranging from 2.1 to 2.5% ash ranging from 1.02 to0.92% fat ranging from 6.23 to 6.24% and nitrogen-free extract (NFE) ranging from 9.92 to 10.135% fermented black sesame beverage exhibited total solids ranging from 19.14 to 22.885% protein from 4.1 to 2.1% ash from 0.7 to 0.82% fat from 7.89 to 7.95% and nitrogen-free extract (NFE) from 8.35 to 10.19%. When comparing fermented black sesame beverage with other types, it is evident that black sesame beverage has a slightly higher content of fat and protein. These findings align with previous research by [77], which reported an increase in total solids, fat, and ash content with prolonged storage in all treatments. However, the protein content exhibited a slight decrease during storage, consistent with studies conducted by [78,79]. Furthermore, the non-nitrogenous compounds in black sesame milk decreased compared to other types, and all treatments demonstrated a gradual decrease during storage. The study also observed an increase in acidity in all types of fresh fermented sesame milk during storage. The rate of acidity development was similar across all treatments. The pH values of all treatments followed an opposite trend to acidity, as reported by [80].

Table (5): The effect of storage period (days) on chemical composition (%) of Probiotic Fermented dairy beverage made from different sesame seed verities on dry weight

Treatments	Storage period (days)	FCMB	FWSB	FSSB	FHSB	FBSB
Total solid	Fresh	21.75 ^{a} ±0.2	22.47 ^{a} ±0.4	20. 85 ^{a} ±0.1	19.84 ^{ab}±0.2	22.88 ^{a} ±0.09
	7	19. 75^{a} ± 0.07	19.73 ^{a}±0.22	20. 29 ^{a}± 0.54	19.41^{ab}±0.17	1 9.49 ^{ab} ±0.09
	15	1 9.53^{ab}±0.29	19.57^{ab}±0.13	19. 69 ^{ab}±0.3	19.16 ^{ab}±0.3	19.14 $^{a\ b}$±0.14
Protein	Fresh	3.7 ^{ab} ± 0.11	4.0^{a} ±0.14	3.1 ^{b} ±0.19	2.5 ^{c} ±0.05	4.1 ^{a} ± 0.16
	7	2.6 ^{b} ±0.13	2.5 ^{c} ±0.23	2.7 ^{b} ±0.28	2.13 ^{c} ±0.06	2.12 ^{c} ±0.30
	15	2.28 ^{c} ±0.4	2.3 ^{c} ±0.26	2.2 ^{c} ±0.22	2 .1 ^{c} ±0.27	2.1 ^{c} ± 0.27
Ash	Fresh	0.75 ^{a} ± 0.06	0.79 ^{a} ± 0.2	0.8 ^{a} ±0.2	1.02 ^{a} ±0.48	0.7 ^{a} ±0.7
	7	0.8 ^{ab} ± 0.15	0.58 ^{ab} ± 0.05	0.87 ^{a} ±0.07	0.88 ^{a} ±0.08	0.75 ^{a} ±0.03
	15	0.85 ^{b} ± 0.25	0.97 ^{a} ± 0.03	0.95 ^{a} ±0.09	0.92 ^{a} ±0.02	0.82 ^{b} ±0.02
Fat	Fresh	3.50 ^{b} ±0.01	6.01 ^{ab} ±0.5	6.23 ^{ab} ±0.02	6.23 ^{ab} ±0.01	7.89 ^{c} ±0.09
	7	3.50 ^{b} ±0.03	6.02 ^{a} ±0.03	6.24 ^{a} ±0.02	6.23 ^{ab} ±0.04	7.92 ^{b} ±0.02
	15	3.60 ^{a} ±0.03	6.02 ^{a} ±0.06	6.24 ^{a} ±0.01	6.24 ^{a} ±0.08	7.95 ^{a} ±0.04
NFE	Fresh	13.80 ^{a} ±0.01	11.67 ^{a} ±0.02	10.72 ^{a} ±0.11	10.09 ^{b} ±0.01	10.19 ^{a} ±0.02
	7	12.85 ^{b} ±0.03	10.4 7 ^{b} ±0.1	10.48 ^{b} ±0.06	9.92 ^{c} ±0.02	8.35 ^{c} ±0.03
	15	12.8 ^{b} ±0.03	10.44 ^{c} ±0.13	10.21 ^{c} ±0.08	10.13 ^{a} ±0.03	8.62 ^{b} ±0.03
PH	Fresh	4.4 ^{d} ± 0.04	4.94 ^{b} ± 0.04	5.12 ^{a} ± 0.23	5.14 ^{a} ± 0.13	4.68 ^{a} ± 0.08
	7	4.26 ^{c} ± 0.26	4.83 ^{ab} ±0.03	5.08 ^{a} ± 0.09	4.59 ^{bc} ± 0.50	4.4 6 ^{b} ±0.03
	15	4.14 ^{c} ± 0.14	4.67 ^{a} ± 0.07	4.75 ^{a} ± 0.21	4.62 ^{ab} ±0.02	4.4 1 ^{b} ± 0.01
Acidity	Fresh	0.7 ^{a} ±0.15	0.65 ^{a} ± 0.17	0.67 ^{a} ± 0.12	0.63 ^{a} ± 0.06	0.45 ^{b} ± 0.09
	7	0.85 ^{a} ± 0.05	0.67 ^{b} ± 0.75	0.77 ^{a} ± 0.95	0.67 ^{b} ± 0.35	0.5 ^{c} ± 0.10
	5	0.96 ^{a} ± 0.10	0.69 ^{c} ± 0.94	0.81 ^{a} ± 0.07	0.7 2 ^{c} ± 0.02	0.6 ^{d} ±0.15

Where: FCMB, fermented cow's milk. FWSB, fermented whitesesame milk. FSSB-3 fermented shandwilsesame milk. FHSB-1, fermented sohagy sesame milk. FBSB, fermented black sesame milk; Each value in the row followed by the same letter isn't significantly different at ($p < 0.05$) *

3.7. Color Analysis of Fermented Sesame Beverages

Color is a critical quality characteristic of fermented dairy products [15].In Table 6, the colorparameters (*a**, *b** and *L**) of different fermented sesame beverages contrasting colors of cow milk and white sesame beverage. However, there were no significant differences between thefermented shendwil 3 and sohagy 1 beverages, although both showed a significant were studied. The lightness (*L **) of fermented cow milk and fermented white sesame beverage exhibited significant increases, with values of 76.21 and 71.98, respectively. This difference can be attributed to the decrease compared to the fermented cow milk and white sesame beverage. The fermented black sesame beverage exhibited the lowest lightness value, indicating a darker color, possibly influenced by seed color variations. To examine the impact of a coloring agent, 1% vitrac strawberry syrup was added. Consequently, all fermented beverages exhibited a shift towards redness, resulting in a pink color. The intensity of the pink color varied depending on the color of the sesame beverage, ranging from dark to light. The fermented cow milk displayed a significant increase (23.29) in the a* value, followed by the fermented white sesame beverage (20.34), fermented shendwil 3 beverage (19.18), and fermented sohagy 1 beverage (17.5). Conversely, the fermented black sesame beverage demonstrated a significant decrease (10.79) in the a* value, indicating less redness, which can be attributed to the effect of sesame seed color. Regarding the b^*color parameter, the current findings revealed that the darkness of seed color had a diminished impact when vitrac strawberry syrup was used as a coloring agent. The b^* value reached its maximum (12.08) in the fermented black sesame beverage and its minimum (1.02) in the fermented cow milk, indicating the darkest and lightest colors, respectively. These findings highlight the influence of seed color and the addition of vitrac strawberry syrup on the color parameters of fermented sesame beverages. Further research is needed to explore the sensory implications and consumer preferences associated with these color variations.

Table 6: Color measurement of fermented sesame seed beverage

Treatments	FCMB	FWSB	FSSB	FHSB	FBSB
*L**	$76.21^{a} \pm 0.3$	$71.98^{b} \pm 0.33$	$70.9^{c} \pm 0.25$	$70.58^{c} \pm 0.25$	$63.27^{d} \pm 0.3$
*a**	$23.29^{a} \pm 0.25$	$20.34^{b} \pm 0.2$	$19.18^{d} \pm 0.12$	$17.5^{c} \pm 0.25$	$10.79^{e} \pm 0.03$
*b**	$1.02^{d} \pm 0.03$	$2.0^{c} \pm 0.089$	$4.33^{b} \pm 1.02$	$4.38^{a} \pm 0.02$	$12.08^{a} \pm 0.28$

*L**= lightness color score, *a** = redness color score, *b** = yellowness color score; Where: -FCM,fermented cow's milk FWSB, fermented whitesesame beverage FSSB-3 fermented shandwilsesame beverage FHSB-1, fermented sohagysesame beverage FBSB, fermented black sesame beverage; Each value in the same row followed by the same letter isn't significantly different at (p< 0.05) *

3.8. Microbial quality control for all fermented beverages of sesame milk verities during storage period 15 day at 7±2°C.

Table (7) shows the total bacterial count, *E. coli*, and yeast and mold in all fermented prebiotic beverages during 15 days storage period at a temperature of 7±2°C. The results were fixed at the second dilution for yeast and mold and at the first dilution for total bacterial count and coliform group. Notably, yeast and mold were not detected in any of the prebiotic beverages at the beginning, and *E. coli* was not detected during the entire storage period. There were significant differences between samples during the storage period, with the total bacterial count showing a significant increase in the FWSB treatment, recording 6, 6.5, and 7 CUF at 5, 10 and 15 days of storage. Conversely, the lowest bacterial count was found in the FHSB-1 treatment, recording ND, 2.0 and 3.0 over different storage periods. Regarding mold and yeast, the highest count was found in the FCMB sample (113.3 CUF) at the end of storage period, while the FHSB-1 sample recorded "not detected," followed by the FBSB sample, which recorded 7.75, 20.0 and 25.0 overall 5,10 and 15 storage periods (days). Overall, the FHSB-1 and FBSB samples had the lowest microbial and yeast/mold count compared to the others, possibly due to the high antioxidant and oil contents, which negatively influenced the growth of microorganisms, mold, and yeast and positively affected shelf life. Additionally, a variety of phytochemical compounds have been identified and isolated from sesame seeds, seed oils, and various plant organs, including polyphenols, phytosterols, phenols, aldehydes, anthraquinones, naphthoquinones, triterpenoids, and other organic compounds. Sesame oil is used as an antimicrobial[8]and as an antioxidant[9]. Sesamealso contains important functional components such as sesamin, sesamolin, sesamol, sesaminol, sesamolin phenol, and other lignan-like activeingredients [12].

Table 7: Microbial quality control for all sesame verities beverages during storage period (15 days) at 7±2 °C

Treatments	Storage	FCMB	WSFB	FSSB-3	FHSB-1	FBSB
C.G	Zero	ND	ND	ND	ND	ND
TBC(10)	5	$3^{bc} \pm 0.5$	$6.0^{a} \pm 0.5$	$0.25^{e} \pm 0.5$	ND	$1.25^{de} \pm 2.5$
	10	$4.0^{b} \pm 0.7$	$6.5^{a} \pm 0.1$	$3.0^{bc} \pm 1.0$	$2.0^{cd} \pm 0.98$	$2.0^{cd} \pm 0.99$
	15	$5.5^{b} \pm 0.099$	$7.0^{a} \pm 1.01$	$2.5^{bcd} \pm .99$	$3.0^{bc} \pm 0.88$	$4.0^{b} \pm 0.7$
	Zero	ND	ND	ND	ND	ND
M &Y (10^2)	5	$16.0^{i} \pm 0.11$	$3.0^{k} \pm 0.14$	$20.25^{h} \pm 0.19$	ND	$7.75^{j} \pm 0.55$ 0.55fgh
	10	$90^{b} \pm 0.1$	$29.5^{f} \pm 0.5$	$59.5^{c} \pm 0.77$	ND	$25.0^{g} \pm 1.0$
	15	$113.3^{a} \pm 0.45$	$52.0^{d} \pm 0.12$	$39.5^{e} \pm 0.7$	ND	$20^{h} \pm 0.77$

TBC: Total bacterial count at first dilation & C.G Coliform group not detected, M &Y: Mould and Yeast at the second dilation, ND: Not detected.; Where: -FCM,fermented cow's milk FWSB, fermented white sesame beverage FSSB-3 fermented shandwil sesame beverage FHSB-1, fermented sohagy sesame beverage FBSB, fermented black sesame beverage; Each value in the same row followed by the sameletter isn't significantly different at (p< 0.05) *

3.9. Comparative Analysis of Total Costs for Various Recipes of Fermented Sesame Beverages.

Table (8) represents the total cost and preparation cost percentage of various recipes for fermented cow milk and fermented sesame milk beverages. The findings indicate that the total cost for fermented white sesame beverage (FWSB), fermented shendwil- 3 sesame beverage (FSSB-3), fermented Sohagy1 sesame beverage (FHSB), and fermented black sesame (FBSB) beverages were15, 15, 15 and 22 L.E. respectively, whereas the control group, fermented cow beverage, cost 36L.E The fermented sesame varieties demonstrated a greater cost reduction compared to the fermented cow beverage due to the disparity in the prices of cow milk and sesame beverage with FWS, FSS-3, and FHS-1 blends achieving the maximum cost reduction of 58.3% each, followed by FBS with a cost reduction of 38.8% in comparison to the control. These findings highlight the potential of fermented sesame milk beverages as a low-cost, healthy, and acceptable alternative, particularly for individuals with lactose intolerance. Additionally, sesame seed meal can be combined with other food sources to develop value-added products that contribute to improved dietary quality at a reduced expense. Such utilization of sesame seed meal may have a positive impact on nutritional status and help combat malnutrition [81].

Table 8: Total cost of different fermented sesame beverages recipes

Ingredients	Cost (L.E) *	FCMB	FWSB	FSSB-3	FHSB-1	FBSB
Cow milk (1 L)	35	35				
WS (kg)	100	-	14.00	-	-	-
SS-3(kg)	100	-	-	14.00	14.00	-
HS-1 (kg)	100	-	-	-	-	-
BS (kg)	150	-	-	-		21.00
Vitrac (650ml)	65	1.00	1.00	1.00	1.00	1.00
Total cost (L.E)	-	36.00	15.00	16.00	16.00.	23.00
Cost reduction (%)	-	-	58.33-	58.33-	58.33-	38.8-

Where: FCM, fermented cow's milk. FWSB, fermented white sesame beverage. FSSB-3 fermented shandwil sesame beverage. FHSB-1, fermented sohagy sesame beverage FBSB, fermented black sesame beverage; L.E =Egyptian pound*

4. Conclusion

The study conducted on different sesame seed varieties showed that Sohagi 1 had the highest weight per thousand seeds (3.23 g). White sesame and Shindeel 3 had similar weights (2.85 - 2.83 g) respectively, while black sesame was the lightest (2.26 g). The lowest apparent density was black sesame 041 g/ml. The sphericity of the seeds ranged from 26% to 33% and the porosity ranged from 40.38% to 60.28%. The chemical composition showed differences in oil, protein, ash and NEF content of different varieties. Significant differences in mineral elements were also found among sesame varieties. Sohagi 1 had a high concentration of zinc, while black sesame showed increased potassium, phosphorus and iron. White sesame and Shindeel 3 had higher levels of phosphorus and calcium. Fatty acid composition varied between varieties, with Sohagy 1 having the highest monounsaturated fatty acid content. Fermented sesame beverage products also showed differences in total solids, ash, fat, protein and NFE content, with Sohagy 1 having the highest ranges. Microbial counts were lower in FHS-1 and FBS samples. Lower cost was observed in fermented sesame recipes, with the highest in FWS, FSS-3 and FHS-1 blends followed by FBS compared to FCM beverages.

5. Recommend

Fermented sesame Probiotic beverages, (particularly Sohagy1, a new variety under evaluation in this research) provide a nutritious and cost-effective option, especially for individuals with lactose intolerance, and can treat nutritional deficiencies and malnutrition. Incorporating sesame seed flour into various food products enhances dietary diversity due to their importance as valuable sources of essential minerals, fatty acids and other beneficial components.

6. Conflict of interest

The authors declare no conflict of interest in achieving this research study.

7. Funding sources

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8. Reference

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