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Research Article

Comparative evaluation of the amino acid's concentration in the visceral organs (liver, heart, gizzard) of male and female common quail [Coturnix coturnix (L. 1758)]

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Abstract:

Introduction: Quail is a collective name for several general of mid-sized birds generally considered in the order Galliformes. Common quail (*Coturnix coturnix*) is a small bird in the pheasant family Phasianidae. Quail meat is attractive for its tenderness, juiciness, flavor peculiar to a slight flavour venison.

Methods: Samples were separately defatted, hydrolysed and neutralized. The AA solution was purified by cation-exchange solid-phase extraction, derivatized and analysed by gas chromatography.

Results: Samples were labelled as female liver (FL), male liver (ML), female heart (FH), male heart (MH), and female gizzard (FG) and male gizzard (MG). Values of protein/total amino acids (g/100g) were: FL(71.5/94.5), ML(71.2/96.2), FH(67.8/95.4), MH(69.0/95.7), FG(66.8/88.2), and MG(68.0/90.5). Glu was the most concentrated AA(16.3-18.9g/100g)(a NEAA). These two EAAs were the most concentrated EAAs as follows: Lys (in FL, ML, FG, MG) and Leu (in FH, MH). AA concentration variations were low at CV% values range of 3.77 – 42.3. These pairs were significantly different at r = 0.01: F/M (liver), F/M (heart), F/M (gizzard) in female/male; L/H, L/G, H/G in the female bird; L/H, L/G, H/G in the male bird. Among all the samples, these ranges were observed: EAA = 38.8 - 47.9g/100g; NEAA = 47.5 – 52.9g/100g; pI = 5.04 – 5.62; EAAI (egg standard) = 89.4 -96.7; BV = 86.3 – 93.7, Lys/Trp = 9.19 – 20.3 and NI = 61.0 -64.6. EAA/N-EAA showed no significant (at r = 0.01) difference among the samples. In the AA scores, the LAAS in the samples were; whole hen's egg comparison: Trp (FL, ML, FG, MG) and Ser (FH, MH); provisional EAA scoring pattern: Trp (FL, ML, FG, MG) and Met+Cys (FH, MH); pre-school child EAA requirements: Trp (FL, ML, FH, MH, FG, MG). In the estimates of amino acid requirements of ages 10-12y (mg/kg/day) all the samples had better concentrations than the standards, shown as follows; total EAAs standard/sample value: 7830/27671 (FL), 7830/26239 (FH), 7830/24248 (FG), 7830/28195 (ML), 7830/29256 (MH) and 7830/25500 (MG). Comparisons of EAAs of the samples with FAO/WHO/UNU showed all the samples to be of better concentration as shown: FAO/WHO/UNU/EAAs of samples (g/100g): 33.9/42.6(FL) / 43.2(ML) / 47.9(FH) / 46.3(MH) / 38.5(FG) / 40.2(MG).

Conclusion: All the samples were good sources of EAAs and will all also complement/fortify EAA deficient food substances.

Key words: coturnix coturnix heterosexuals, visceral organs, amino acids, nutritional index

Introduction

In the rural areas, the goats breeding along with ewes have been the main sources of milk to families since ancient times [1]. Moreover, an increase in milk demand can be overcome by increasing small ruminants such as goats [2]. Hence, the increasing in production of goats is due to growing demands for ovine milk by consumers [3]. This because some components in goat milk have more advantages of specific benefits in human nutrition and food security than other dairy species [2]. The nutritional and therapeutic values of goat milk make special for human consumption [4].

Fermented goat's milk products could represent a good opportunity to increase the supply of dairy products with greater nutritional value [4,5]. Goat's milk is particularly suitable for the production of yoghurt, due to its composition as well as providing numerous health benefits [6]. In addition, yoghurt has a refreshing pleasant, organoleptic and high nutritive value [7].

The sensory properties of dairy products such as flavor, texture and appearance attributes, determine consumer acceptability and willingness to repeat purchase of a product, with some additional contribution from

their nutritional value and wholesomeness [8]. In this regards, the common mish flavoured with black cumin and fenugreek revealed high production and sale ratio compared with the newly spicy mish that flavoured with cumin and pepper [9].

Black cumin (Nigella sativa) is an annual plant that belongs to the Ranunculaceae family, with antimicrobial, anti-inflammatory, antioxidant, antidiabetic, gastroprotective and hepatoprotective activities [10]. Black cumin showed significant preservative effect in improving the keeping quality of the dairy products [9,11,12,13]. Moreover, increase of the total phenolic characteristic and antioxidant activity of yoghurt fortified with black cumin and honey indicate the possibility of consuming bioactive yoghurt [14]. Also, the addition of germinated black cumin seeds extract improved some of the physicochemical and bioactive properties of fortified yoghurts including antioxidant and antidiabetic properties [15].

Coriander (Coriandrum sativum L.) is an annual herb aromatic plant belonging to the Apiaceae family [16]. Coriander has been used as a spice for medicinal and food purposes since long ago [17]. Coriander seeds has antioxidant, antimicrobial, anti-inflammatory, anticoagulant, anticonvulsant and analgesic properties [17,18]. It is used for digestion problems [19]. Also, yoghurt, fresh and cream cheese to give aroma and taste [20]. The addition of coriander seed powder and probiotic strains to yoghurt can improve its nutritional and functional properties [16]. Moreover, yoghurt fortified with Coriaandrum sativum has longer shelf-life, more nutritious and has more consumer acceptance [21]. On the other hand, smoking using Coriandrum sativum seed was found to improve the keeping quality and acceptability of Mudaffara cheese [22].

Mish is a sour traditional popular dairy product that is currently produced by commercial dairy companies with a shelf-life of more than 21 days in Sudan [9,11,23].

Goat milk can be used to prepare a wide variety of dairy products such as yoghurt [24]. Goat milk yoghurt is an excellent source of fatty acids, proteins, and minerals, however, it is not well accepted by many consumers, due to its typical flavor derived from caprylic, capric, and caproic acids present in this milk and its dairy products [25]. Also, goat's milk and its products are not accepted in Sudan because of the mild "goaty flavor" in fresh goat's milk. although, the production and processing of goat's milk is of vital nutritional and social importance in the rural areas of Sudan. In order to make the goat's milk acceptable, the addition of black cumin (Nigella sativa) and coriander (Coriandrum sativum) seeds is tried in this stuy in order to improve the quality of goat milk. Thus, it is meant in this study to produce an intermediate product (yoghurt mish) between yoghurt and mish by making use of goat milk. So the formulated product can be made by women in rural and urban areas to utilize goat milk. The effect of adding the selected spices seeds on the chemical composition and sensory characteristics of the produced product during the storage was also evaluated.

Materials and methods

Source of materials

Fresh goat's milk was obtained from Kuku Research Center Farm, Hilat Kuku, Khartoum during September 2019. The milk samples were collected, cooled and transported to the laboratories of the Department of Dairy Production, Faculty of Animal Production, Khartoum University, for processing and analysis.

The yoghurt starter culture (Streptococcus thermophilus and Lactobacilus bulgaricus), a product of CHR-HANSEN (YoFlex® Express 1.0) were bought from the local market at Khartoum State. Also, coriander, black cumin, and plastic cups were purchased from the local market.

Preparation of yoghurt mish

Yoghurt mish was produced using goat's milk with addition of spices. Three yoghurt mish samples were prepared as follows,

1. The first sample (control) was made from goat's milk only (plain).
2. The second sample was made with goat's milk fortified with 0.5% coriander seeds.
3. The third sample was made with goat's milk fortified with 0.5% black cumin seeds.

Processing of yoghurt mish

The milk was heated to 95ºC for 10 minutes, and then allowed to cool with constant gentle agitation to an incubation temperature of 45ºC. The yoghurt starter culture was added at the rate of 3% (w/v). The milk was poured into plastic cups, covered and incubated at 42-45ºC for 4 hours, then coriander or black cumin seeds, were added to the treated samples, after incubation at the rate of 0.5%. The cups then placed in the refrigerator at 4ºC for 15 days. The chemical and sensory analysis were conducted at the 2nd, 7th and 15th day's during the storage.

Chemical analysis of yoghurt mish

The total solids content was determined according to the modified method of AOAC method [26]. The fat content was determined by Gerber method [27]. The protein content was determined by Kjeldahl method [26]. The ash content was determined using gravimetric method and the titratable acidity of yoghurt mish was determined by the titeration method [26].

Sensory evaluation

Yoghurt mish samples were subjected to sensory evaluation using 10 semi-trained panelists at the 2nd, 7th and 15th day's of the storage. The panelists were asked to rank the samples for the appearance, color, flavor, texture, taste and overall acceptability using 5 points hedonic scale with 5 as the highest score and 1 as the lowest [28].

The samples were given codes before being tested. The tests were done in duplicate.

Statistical analysis

General Linear Model (GLM) was used to determine the effect of type of spices (coriander and cumin, 0.5%, and storage period, 2nd, 7th and 15th day's, on the chemical composition as well as sensory characteristics scores of yoghurt mish. Mean separation was done using Duncan Multiple Range test at $P \leq 0.05$ [29].

Results and discussion

Effect of adding black cumin and coriander to goat milk yoghurt mish

Table 1 presents the chemical composition of yoghurt mish as affected by the addition of black cumin and coriander seeds. The total solids content of yoghurt mish was significantly ($P<0.05$) affected by the addition of the used seeds, where the highest total solids content was obtained in yoghurt mish fortified with coriander seeds (12.75±0.09%) than that fortified with black cumin seeds (12.58±0.14%) and the control yoghurt mish sample (12.40±0.33%). This due to the reason that coriander seeds powder are good source of protein, fiber and ash [16]. The mish samples showed 11.83±2.96% for total solids content [13]. However, higher value for the total solids was reported in the commercial mish samples (20.91±0.27%) [30]. Also, mudaffara cheese smoked with coriander seeds was significantly ($P<0.05$) higher in total solids contents compared to the control cheese [22]. It worth to mention here that goat milk and its processed products are useful as functional foods because they maintaining the nourishment and health of both young and elderly people, especially those suffering from allergy to cow milk [24].

The fat content (Table 1) was significantly (P<0.05) higher in yoghurt mish fortified with black cumin seeds (4.35±0.04%) followed by the control yoghurt mish samples (4.26±0.08%) compared to yoghurt mish fortified with coriander seeds (4.01±0.01%). The average value of fat content for mish samples fortified with black cumin seeds revealed 5.05±0.2 [30]. However, lower value (2.83±0.93%) was obtained for fat content of mish samples [13]. On the other hand, goat milk has unique nutritional values, which is superior to milk from other species including cows because of it's easy digestion and the good composition of fatty acids [1]. Moreover, goat's milk is naturally homogenized and contains greater proportion of smaller fat globules that are easier to digest than cow's milk [31]. The lower value reported for yoghurt mish fortified with coriander seeds could be because of the reason that coriander seeds were found to enhance the breakdown of lipids [32].

The protein content of yoghurt mish (Table 1) was significantly (P<0.05) higher in yoghurt mish fortified with coriander seeds (3.80±0.26%) followed by that fortified with black cumin seeds (3.20±0.01%) compared to the control yoghurt mish samples (2.76±0.14%). The obtained value for the protein content supported those reported perviously[33]. Significant (P<0.05) high protein content was obtained also for mudaffara cheese smoked with coriander seeds [22]. Moreover, the analysis of coriander seeds powder showed that the seed is a good source of protein [16]. Yoghurt with high protein content showed more popularity and increased consumers acceptance due to improvement of taste, texture and values in human health [21]. The average values of protein for mish samples containing black cumin seeds were 5.09±2.9% [13] and 8.08±0.14% [30]. Moreover, goat milk has good content of protein and its content of bioactive compounds makes it more of medicinal value than a mere food [1]. Also, goat's milk has less allergenic risk due to its different protein structure (casein micelle) and components hence, it is usefully as an alternative to cow's milk [4].

The ash content of yoghurt mish (Table 1) was significantly (P<0.05) affected by the addition of the used seeds, the highest ash content was obtained in coriander seed fortified yoghurt (0.83±0.02%) followed by the black cumin seed fortified yoghurt (0.75±0.03%) compared to the control yoghurt samples (0.73±0.04%). This due to the high ash content of coriander seeds [16]. Moreover, the Coriandrum sativum contains ingredients that are healthful for humans including macro- and micro-minerals and vitamins [21]. Lower values for ash content in mish samples were reported as 1.26±0.61% [13] and 1.43±0.18% [11]. The mean of ash content was 2.60±0.043% for common mish and 2.78±0.078% for newly spicy mish [34].

The acidity was significantly (P<0.05) affected by the addition of the two spicy seeds (Table 1), where the highest value of acidity was obtained in coriander seed fortified yoghurt (0.10±0.003%) followed by the black cumin seed fortified yoghurt (0.08±0.002%) compared to the control yoghurt samples (0.07±0.002%). However, the acidity in mish samples was reported as high as 1.24±0.41% [13] and 2.015±0.08% [30]. Similarly, mudaffara cheese smoked with coriander seed revealed significantly (P<0.05) lower acidity compared to the control cheese [22]. This is because the presence of spices in yoghurt causes retardation of bacterial growth and decreases the changes occurred during fermentation process [35]. The variations in acidity could be due to the antimicrobial properties of black cumin [11,12,13,35]. However, the higher dry matter and protein content lead to higher titratable acidity [33,36,37]. It worth to mention here that mish is different from yoghurt in its higher acidity content [10].

Parameters	Treatment (%)			S.L.
	Control yoghurt	Yoghurt with 0.5 black cumin	Yoghurt with 0.5 coriander	
Total solids (%)	12.40^{b}±0.33	12.58^{b}±0.14	12.75^{a}±0.09	***
Fat (%)	4.26^{a}±0.08	4.35^{a}±0.04	4.01^{b}±0.01	*
Protein (%)	2.76^{b}±0.14	3.20^{b}±0.01	3.80^{a}±0.26	***
Ash (%)	0.73^{a}±0.04	0.75^{a}±0.03	0.83^{a}±0.02	N S
Acidity (%)	0.07^{a}±0.002	0.08^{a}±0.002	0.10^{a}±0.003	N S

Means within the same row bearing similar letters are not significantly different (P>0.05).
S.L. = Significance level
*** = P<0.001
** = P<0.01
* = P<0.05
N S =Not significant

Table 1: Phsico-chemical feature of goat milk yoghurt mish containing cumin and coriander seeds

Effect of storage period on the chemical composition of goat milk yoghurt mish

Table 2 showed that the total solids contents of goat milk yoghurt mish increased from 12.37±0.18% at the 2nd day of storage period to 12.60±0.19% and 12.77±0.24% at the 7th and 15th days of storage, respectively. The increase in total solids content of goat yoghurt mish towards the end of storage period is in agreement with those reported previously [38]. Significant differences (P<0.05) was found previously for the total solids of mish samples during the storage period [34]. Also, the total solids value in mish samples showed increased trend during the storage period [30].

The fat content of yoghurt mish was high at the 2nd day of storage period (4.28±0.09%) and was then decreased at the 7th and 15th days of storage to 4.20±0.06% and 4.15±0.08%, respectively (Table 2). This result is in line with those reporting that the highest fat content of probiotic yoghurt was found during the 2nd day of storage and the lowest on the 15th day of storage [39]. Similarly, highly significant differences (P<0.001) were reported for the level of fat between mish samples [9]. The reason might be because the coriander decreases the uptake and enhances the breakdown of lipids and can be used as preventive and curative herbal against hyper lipdemia [32].

The protein content of yoghurt mish (Table 2) was high at the 2nd day of storage period (3.58±0.30%) and showing a decreasing trend at the 7th and 15th days (3.31±0.14% and 2.86±0.18%, respectively). The reduction could be because during the fermentation process evolves the yoghurt antioxidant activity by releasing various bioactive peptides and free amino acids during lactic acid fermentation [40,41]. The fat and protein

content of goat milk yoghurt were significantly (P<0.001) affected by the storage period. The reduction of protein content of cheese might be due to its degradation by the proteolytic activity of the microorganisms [12].

The ash content of yoghurt mish decreased from 0.81±0.02% at the 2nd day of storage period to 0.80±0.03% and 0.71±0.05% at the 7th and 15th days of storage, respectively (Table 2). Similarly, higher values (2.03±0.096%) was reported for the ash content of mish samples at day 1 compared to that obtained at day 21 (1.47±0.096%) of the storage periods [42]. However, the ash content of commercial mish showed non-significant (P>0.05) reduction during the storage period [30].

The acidity of goat milk yoghurt mish was significantly (P<0.001) increased from 0.07±0.005% at the 2nd day of storage period to 0.08±0.005% and 0.09±0.005%, respectively at the 7th and 15th days of storage period (Table 2). This is in line with the result reported previously [33,36,37]. Similarly, significant (P<0.05) increase in the acidity of yoghurt fortified with coriander seeds was found [16]. The increase in acidity with advancing storage period agreed with those showing that the total acidity of the resultant fermented milk increased during storage [38]. Also, highly significant differences were reported for the level of acidity between mish samples during the storage [34]. Similarly, the acidity of the mish samples showed highly significant (P<0.001) increase, while the pH content showed highly significant (P<0.001) decrease from day 2 to day 20 [30]. The rapid decrease of pH values of goat milk during fermentation activity of lactic acid bacteria in goat milk is due to its specific composition and structure [43]. Moreover, this decrease in pH causes the increase in titratable acidity during storage, because lactic acid bacteria ferment lactose to produce lactic acid [36].

Measurement	Storage period \/days			S.L.
	2	7	15	
	Mean± S.E	Mean± S.E	Mean± S.E	
Total solids (%)	12.37^{a}±0.18	12.60^{a}±0.19	12.77^{a}±0.24	N S
Fat (%)	4.28^{b}±0.09	4.20^{a}±0.06^{a}	4.15^{b}±0.08	**
Protein (%)	3.58^{a}±0.30	3.31^{a}±0.14	2.86^{b}±0.18	***
Ash (%)	0.81^{a}±0.02	0.80^{a}±0.03	0.71^{a}±0.05	N S
Acidity (%)	0.07^{b}±0.005	0.08^{b}±0.005	0.09^{a}±0.005	***

Means within the same row bearing similar letters are not significantly different (P>0.05).
S.L. = Significance level
*** = P<0.001
** =P<0.01
N S =Not significant

Table 2: Effect of storage period (days) on the chemical composition of goat milk yoghurt mish fortified with black cumin and coriander seeds

Changes among storage period (days) on the chemical composition of goat milk yoghurt mish

Table 3 showed that the fat, protein, total solids, ash and titratable acidity contents of the yoghurt mish were significantly (P<0.05) affected by the storage period and spices used. Generally, the chemical composition of goat's milk yoghurt was significantly (P<0.05) reduced during the storage period [7]. In Sudan, the commercially available yoghurt in Khartoum State markets has a good compositional quality in comparison to the international standards [44].

Coriander seeds at 0.5% gave the highest total solids, protein, ash and acidity content in yoghurt mish (Table 3). This is because coriander has higher amounts of amino acids, proteins, minerals, carbohydrates and fats [21]. Also, the coriander contain fibers, vitamins and minerals that make it a suitable material to promote bacterial growth [45]. Furthermore, the biological activities of coriander are the main reason to the increase of its potential uses as a functional food for the health-giving additives industry [19]. Meanwhile, the black cumin seeds at 0.5% gave the highest fat content in yoghurt mish made from goat milk (Table 3). Proximate analysis of black cumin (Nigella sativa L.) seeds showed as much as 45.4% fat [46]. On the other hand, the chemical composition of the yoghurt depends mainly on the production conditions, the qualities of the raw milk, structure of the yoghurt grains or starter culture, fermentation time and the storage conditions [7]. The highest total solids, protein, ash and acidity contents found in the 2nd day of the storage and the lowest on the 15th day of the storage. Similarly, the protein and fat contents were significantly (P<0.001) reduced in mish samples examined at day 20 (7.61 and 4.57%, respectively) compared to those tested in day 2 (8.55 and 5.53%, respectively) [30]. Also, the highest fat content was found at the beginning of the storage and the lowest ones at the end of the storage of probiotic yoghurt [39]. The degradation of protein and lipolytic activity on the fat content are the reason for the decrease of the total solids content of cheese [12]. On the other hand, and similar to the present study, significant (P<0.05) differences were found in the acidity of yoghurt samples during storage [16]. A previous report also indicated that addition of spices to yoghurt decrease its acidity content and consequently suppress the bacterial growth [47].

Storage period/ day	Types of yoghurt	Chemical composition				
		Total solids (%)	Fat (%)	Protein (%)	Ash (%)	Acidity (%)
2	Control	12.00^{b}±0.50	4.45^{a}±0.05	3.00^{cd}±0.00	0.82^{a}±0.08	0.06^{i}±0.001
	Cumin	12.45^{a}±0.15	4.40^{a}±0.00	3.20^{c}±0.00	0.79^{a}±0.02	0.08^{d}±0.002
	Coriander	12.65^{a}±0.05	4.40^{a}±0.00	4.55^{a}±0.05	0.82^{a}±0.06	0.09^{c}±0.002
7	Control	12.05^{a}±0.05	4.35^{a}±0.05	3.00^{cd}±0.00	0.73^{a}±0.07	0.07^{e}±0.001
	Cumin	12.85^{a}±0.35	4.25^{b}±0.05	3.20±0.00	0.79^{a}±0.05^{a}	0.09^{c}±0.003
	Coriander	12.90^{a}±0.10	4.00^{b}±0.00	3.75^{b}±0.15	0.87^{a}±0.00	0.10^{b}±0.002
15	Control	13.15^{a}±0.75	4.00^{b}±0.00	2.30^{e}±0.00	0.64^{b}±0.07	0.08^{d}±0.002
	Cumin	12.45^{a}±0.05	4.40^{a}±0.10	3.20^{c}±0.00	0.69^{a}±0.12	0.09^{c}±0.003
	Coriander	12.70^{a}±0.30	4.05^{b}±0.05	3.10^{cd}±0.10	0.81^{a}±0.04	0.11^{a}±0.002
S L		**	***	***	**	**

Means within the same row bearing similar letters are not significantly different (P>0.05).
S.L. = Significance level
*** = P<0.001
** = P<0.01

Table 3. Changes among storage period (days) on the chemical composition of composition of goat milk yoghurt mish

Sensory characteristics of goat milk yoghurt mish containing cumin and coriander seeds

Table 4 showed that the addition of black cumin and coriander seeds were adversely (P<0.01) affecting the appearance and colour of yoghurt mish. The highest score recorded for appearance was obtained for the control yoghurt mish samples (4.80±0.10) followed by that fortified with black cumin seeds (4.70±0.12) compared to those fortified with coriander seeds (4.40±0.17). Also, the highest colour score was reported for the control yoghurt mish samples (4.83±0.08) followed by yoghurt fortified with black cumin seeds (4.63±0.12) compared to that fortified with coriander seeds (4.50±0.15) as shown in Table 4. This because goat milk has a white colour [24]. The change in color of yoghurt depends upon the used additives [21]. The results of colour scores are in agreement with those reported for mish [9,35].

The flavor score of yoghurt mish (Table 4) was significantly (P<0.01) higher in yoghurt mish fortified with black cumin (4.50±0.13). However, the flavor of common mish fortified with black cumin revealed lower scores compared to that of the newly spicy mish [9]. On the other hand, the scores (4.36±0.15) obtained for the control yoghurt mish samples (Table 4) supported the use of natural culture microorganisms as enhancer for the aromatic characteristics of the goat's fermented milk, without adding sweeteners or other ingredients, which might create interference with fermentation activity [8]. Although, the flavour of goat's milk is more intense in comparison to cow's milk, which can restrict the acceptance of its derivatives by the consumers [48]. The lowest scores was obtained for yoghurt mish samples fortified with coriander seeds (3.86±0.19) as shown in Table 4. This regardless of the fact that coriander has high economic value since it is widely used as flavoring agent in food and cosmetics [19]. Moreover, the use of natural flavouring additives in dairy products such as black cumin and coriander were used as preservatives, antiviral, antibacterial and antifungal compound [49].

The addition of black cumin and coriander seeds were adversely (P<0.001) affecting the texture of yoghurt mish scores (Table 4). The highest texture score (4.70±0.12) was reported for the control yoghurt mish samples compared to the samples fortified with black cumin seeds (4.26±0.13) and coriander seeds (3.80±0.21). This result contradict with those stating that the high protein content improved the texture of yoghurt. The reason could be due to the fact that they added higher levels of coriander seed compared to the current study [21]. Also, the texture scores were reported high in common mish compared to that of the newly spicy mish [9]. The consistency of yoghurt made from goat milk was slightly firm [25,36,50]. The textural attributes, including the desired oral viscosity, are important criteria for quality and consumer acceptance of yoghurt [5].

The taste score was high in yoghurt mish samples fortified with black cumin seed (4.36±0.16) followed by the control yoghurt mish samples (4.16±0.17) compared to that fortified with coriander seed (3.76±0.19) as shown in Table 4. Similar scores were found for the taste of the common and newly spicy mish [9]. This might be because the taste of yoghurt fortified with coriander seed was sour, while still tasty [21].

The highest overall acceptability score was obtained for yoghurt mish fortified with black cumin seed (4.63±0.16) as shown in Table 4 and this in line with the results obtained earlier [35]. The scores for control yoghurt mish samples revealed 4.20±0.14 and the coriander seed fortified yoghurt mish samples revealed 3.96±0.14 (Table 4). Although, the addition of various plant and fruit compounds to a dairy product has a negative effect on the sensory characteristic. Yet, sensory evaluation showed that yoghurt samples containing coriander seed powder and probiotic strains did not have a negative effect on the sensory characteristic of the produced yoghurts [16].

The higher score obtained for the overall acceptability of yoghurt mish (Table 4) could be attributed to the essential oil of black cumin that are reported to increase the sensorial attributes of dairy products [51]. The present results for the overall acceptability are in support to those reported for mish samples [9,35]. Moreover, the overall acceptability scores were reported high in common mish compared to that of the newly spicy mish [9]. On the other hand, higher acceptability of yoghurt produced from goat milk was found compared to that made using powdered milk [50]. As the yoghurt in the modern dairy plants of the Sudan is commonly made using powdered milk [52].

Sensory attributes	Scouring			S.L.
	Control yoghurt	Cumin yoghurt	Coriander yoghurt	
Appearance	4.80^{a}±0.10	4.70^{a}±0.12	4.40^{b}±0.17	**
Colour	4.83^{a}±0.08	4.63^{a}±0.12	4.50^{b}±0.15	**
Flavour	4.36^{a}±0.15	4.50^{a}±0.13	3.86^{b}±0.19	**
Consistency	4.70^{a}±0.12	4.26^{b}±0.13	3.80^{b}±0.21	***
Taste	4.16^{a}±0.17	4.36^{a}±0.16	3.76^{b}±0.19	**
Overall acceptability	4.20^{b}±0.14	4.63^{a}±0.16	3.96^{b}±0.14	**

Mean Means within the same row bearing similar letters are not significantly different (P>0.05).

S.L. = Significance level
*** = P<0.001
** = P<0.01

Table 4: Sensory characteristics of goat milk yoghurt mish containing black cumin and coriander seeds

Effect of storage period on the sensory characteristics of goat yoghurt mish

Table 5 showed that the scores for appearance, colour, flavor, taste and overall acceptability of yoghurt mish were high at the 15th day of storage (5±0.00, 5±0.00, 4.40±0.11, 4.33±0.12 and 4.43±0.10, respectively). The

appearance, colour, taste and overall acceptability scores of yoghurt mish improved from 4.36±0.16, 4.70±0.12, 3.90±0.21 and 4.36±0.17 at the 2nd day of storage to 4.53±0.15, 4.26±0.15, 4.06±0.19 and 4±0.17 at the 7th day, respectively (Table 5). Similar sensory characteristics scores of yoghurts manufactured from goat milk were reported previously [33,53].

Yoghurt mish was acceptable throughout the storage period (Table 5). This might be due to the masking of goaty flavor by lactic acid and other metabolites produced by lactic acid bacteria [54]. Also, the spices that are added to the food contributed positively to its aroma, taste, flavor and colour due to the presence of phenolic compounds in the spices [55]. Moreover, the worldwide increase in the consumption of goat's milk and it is related products is due to its organoleptic and nutritional properties [4].

The results of colour indicated that the highest score of yoghurt mish colour was obtained at the beginning of the storage period. The sensory characteristics of goat's milk yoghurt mish were significantly ($P<0.05$) affected by the duration of storage period (Table 5). The change in sensory attributes is critical to the overall quality of the product as the deterioration of sensory properties is indicated by rapid end of the shelf life [7,36,56,57]. Moreover, the added spices to mish including black cumin were found to extend its shelf-life [35].

Sensory attributes	Treatment			S.L.
	2	7	15	
	Mean± S.E	Mean± S.E	Mean± S.E	
Appearance	4.36^{b}±0.16	4.53^{a}±0.15	5^{a}±0.00	**
Colour	4.70^{a}±0.12	4.26^{b}±0.15	5^{a}±0.00	**
Flavour	4.20^{a}±0.20	4.13^{a}±0.18	4.40^{a}±0.11	N S
Texture	4.46^{a}±0.17	4.23^{a}±0.18	4.06^{a}±0.17	N S
Taste	3.90^{c}±0.21	4.06^{b}±0.19	4.33^{a}±0.12	**
Overall acceptability	4.36^{a}±0.17	4.00^{b}±0.17	4.43^{a}±0.10	**

Means within the same row bearing similar letters are not significantly different ($P>0.05$).
S.L. = Significance level
*** = $P<0.001$
** = $P<0.01$
NS= Not significant

Table 5: Effect of storage period on the sensory characteristics of goat milk yoghurt mish fortified with black cumin and coriander seeds

Changes among storage period on the sensory characteristics of goat milk yoghurt mish

Table 6 showed that the sensory characteristics of goat's milk yoghurt mish were significantly ($P<0.05$) affected by the storage period. The sensory evaluation results showed that the addition of spices improve flavor, taste and the overall acceptability scores of the goat's milk yoghurt mish. The highest scores for colour, appearance, flavor, taste and overall acceptability were found in yoghurt mish stored for 15th days, while the texture score was best when yoghurt mish was consumed at the 2nd days after processing (Table 6). The sensory properties of the yoghurt depend mainly on the production conditions, the qualities of the raw milk, starter culture, fermentation time and the storage conditions [7]. In this study, black cumin and coriander seeds can be used for the manufacture of yoghurt mish as natural flavoring additives with improved organoleptic and nutritional property, in addition to increase the shelf life of yoghurt. This supported the report showing the success of yoghurt processing from goat's milk using some spices powdered and seeds as natural preservatives to improve the flavours of goat's yoghurt, especially cardamom, cinnamon, fenugreek, coriander powder and cumin seeds [47]. Moreover, coriander contains antioxidants, which prevent the spoilage of food [32].

Storage period / day	Types of yoghurt mish	Sensory characteristics					
		Appearance	Colour	Flavor	Texture	Taste	Overall acceptability
2	Control	4.70^{a}±0.21	4.80^{a}±0.13	4.90^{a}±0.10	4.80^{ab}±0.20	4.50^{ab}±0.22	4.70^{ab}±0.21
	Cumin	4.60^{a}±0.26	4.80^{a}±0.13	4.60^{a}±0.26	4.60^{abc}±0.26	4.60^{a}±0.26	4.60^{abc}±0.26
	Coriander	3.80^{b}±0.32	4.50^{ab}±0.34	3.10±0.31^{d}	4.00^{c}±0.36	2.60^{c}±0.22	3.80^{d}±0.35
7	Control	4.70^{a}±0.21	4.70^{a}±0.21	4.30^{ab}±0.36	4.30^{abc}±0.30	4.20^{ab}±0.41	3.90^{c}±0.31
	Cumin	4.50^{a}±0.26	4.10^{b}±0.27	4.50^{ab}±0.26	4.00^{c}±0.25	4.20^{ab}±0.41	4.40^{abcd}±0.40
	Coriander	4.40^{ab}±0.33	4.00^{b}±0.25	3.60^{c}±0.26^{d}	4.40^{abc}±0.40	3.80^{b}±0.13	3.70^{d}±0.15
15	Control	5.00^{a}±0.00	5.00^{a}±0.00	3.90^{bc}±0.17	5.00^{a}±0.00	3.80^{b}±0.24	4.00^{bcd}±0.14^{d}
	Cumin	5.00^{a}±0.00	5.00^{a}±0.00	4.40^{ab}±0.16	4.20^{bc}±0.13	4.30^{ab}±0.15	4.90^{a}±0.10
	Coriander	5.00^{a}±0.00	5.00^{a}±0.00	4.90^{a}±0.10	3.00±0.21^{d}	4.90^{a}±0.10	4.40^{abcd}±0.16^{d}
L.S		*	*	***	***	***	***

Means within the same row bearing similar letters are not significantly different ($P>0.05$).
S.L. = Significance level
*** = $P<0.001$
* = $P<0.05$

Table 6. Changes among storage period (days) on the sensory characteristics of goat milk yoghurt mish

Conclusions

This investigation concluded that the total solids, fat, protein, ash and titratable acidity content of the yoghurt mish were significantly ($P<0.05$) affected during the storage period using both the added seeds. The sensory characteristics of goat's milk yoghurt mish were significantly ($P<0.05$) affected by the storage period together with the added spices that improve the flavor, taste and overall acceptability of the goat's milk mish yoghurt. Hence, it is recommend that both cumin and coriander seeds can be used in the manufacture of yoghurt mish as natural flavoring additives and to increase the shelf life of goat yoghurt mish. Also, facilities to initiate and

sustain the use of milk from goats for processing of dairy products is highly needed.

Author contributions

Salwa Ahmed: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Visualization, Validation, Writing – original draft.

Ibtisam El Zubeir: Conceptualization, Methodology, Investigation, Resources, Supervision, Visualization, Validation, Writing – review & editing.

Availability of data and materials

The data used in the current paper will be available upon request from the crosponding author.

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