Effect of levels of black cumin seeds (*Nigella sativa*) and storage period on biochemical properties and acceptability of Sudanese braided cheese

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**Abstract**

The effect of different levels of black cumin seeds (*Nigella sativa*) and storage period on biochemical properties and acceptability of braided cheese was investigated. Five batches of braided cheese were prepared from cow’s milk, at five different levels of black cumin seeds (0.0%, 0.5%, 1.5%, 2.5%, and 3.5%) and stored for 60 days. Stored cheese was examined at (0, 15, 30, 45 and 60) days intervals. The titratable acidity and formol ripening index (FRI) increased significantly (P ≤0.05) with increasing levels of black cumin, while the pH values decreased significantly (P ≤0.05) with storage period. The total volatile fatty acids (TVFA) of cheese increased significantly (P ≤0.05) with storage time. Sample of cheese containing 3.5% black cumin showed the highest increase of TVFA (74.91 mls 0.1N NaOH). Sample containing 0.0% black cumin seeds showed the lowest increase of TVFA (50.44 mls 0.1N NaOH). Organoleptic quality of cheese revealed that 1.5% level of black cumin seeds secured the highest acceptability (4.54), and the lowest acceptability (3.16) was recorded by sample containing 3.5% level of black cumin seeds. Storage period significantly (P ≤0.05) affected the acceptability. The best acceptability score (4.26) was obtained at day 30, and the lowest score (3.66) at the end of the storage period (60 days).

**Introduction**

Cheese is one of the oldest and most widely used foods. It can be served alone or incorporated into a prepared dish as a principle ingredient or it can be used to accompany a wide array of presentation. White cheese is the main type of cheese in the Sudan. Other cheese varieties include Mudaffara (braided) cheese and Mozzarella cheese. Mudaffara cheese is a semi-hard cheese that forms a product of better keeping quality than the well known white cheese (Abdel-Razig et al., 2001). Mudaffara cheese is characterized by a close texture, Yellow colour and slightly acidic salty
taste (El-Sheikh, 1997). Cheese types that resemble the Sudanese Mudaffara cheese are kashkaval in the Balkan region, Rommi in the Middle East, Cociocoralla in Italy, Ras cheese in Egypt, Magdoula cheese in Syria and paste Filata, a group which includes provolone and mozzarella cheese (El-Sheikh, 1997). The black cumin (*Nigella sativa*) belongs to the family *Ranunculaceae*. It has been used as a herbal medicine for more than 2000 years. It is also used as a food additive and flavour in many countries. Black cumin volatile oil has been shown to possess 67 constituents, many of which have beneficial pharmacological effects on humans (Aboutable et al., 1986). Cumin seeds are small in size of about 2-3 mm long; they have an aromatic odour, intense dull black colour and remarkably angular shape and their surfaces are wrinkled. The seeds are very diverse and rich in nutrients, organic compounds and vitamins (Babyan et al., 1978; Eltayeb, 2005).

Mudaffara cheese production in the Sudan is a small business, and a standard procedure is adopted for its production by the different producers. Moreover, research dealing with the physiochemical, organoleptic, and keeping qualities of Mudaffara cheese is very meagre. The objective of this work is to study the effect of levels of black cumin seeds (*Nigella sativa*) and storage period on the biochemical properties and acceptability of Sudanese braided (Mudaffara) cheese.

**Materials and methods**

**Source of milk**

Fresh cow’s milk (20 Kg for each experimental patch) used for the manufacture of Mudaffara cheese was obtained from the University of Khartoum Farm. Seeds of black cumin (*Nigella sativa*) were obtained from local market.

**Mudaffara cheese Manufacture**

Cow milk (3.8% fat) was heated to 40°C as the optimum temperature for rennet action. Active starter culture 2% v/v was added to milk and left for 15 min in an incubator (40°C) to develop acidity. One tablet of rennet was dissolved in 10 ml cold tap water, and added to milk at 40°C. Milk was stirred for five min to ensure uniform distribution of rennet and then left undisturbed to develop a curd. After complete coagulation, the curd was broken with a wooden paddle into small parts and scalded at the same temperature (40°C) until the required acidity for kneeling was reached (0.46%–0.60%). Ripening was assessed by testing the ability of the curd to be kneeled into a four meter rope, while any breakage before this length was reached would indicate inadequate ripening.

Whey was allowed to drain from the ripened curd before placing it into a wooden plate and then cut into slices during which more whey draining occurred. The curd was then cooked in warm water at 75°C for five minutes, and levels of black cumin seeds (0.0%, 0.5%, 1.5%, 2.5% and 3.5%) were added, and then pulled to form a long rope which was then braided. The samples were kept in salted whey (8% salt) at room temperature (30 ± 6 °C) for 0, 15, 30, 45 and 60 days intervals.

**Biochemical analyses of braided cheese**

The biochemical composition of braided cheese was determined as follows:

Titratable acidity and Total volatile fatty acid (TVFA) was determined according to Kosikowski...
(1982), the pH-value was determined according to Newlander and Atherton (1964), while formal ripening index was determined according to Abdel-Tawab and Hofi (1966).

**Organoleptic quality of cheese**

Ten panelists were chosen to judge the quality of braided cheese in term of appearance, flavour, texture and overall acceptability. The sensory evaluation of braided cheese was evaluated by scoring procedure (headonic scale) described by Ihekoronye and Ngoddy (1985), where 5: excellent, 4: very good, 3: good, 2: acceptable and 1: poor.

**Statistical analysis**

Data were analyzed as complete randomized design with three replicates using statistical analysis system program SAS (1997). Means were separated using Duncan’s Multiple Range Test.

**Results and discussion**

**Chemical properties of braided cheese**

**pH-value**

The levels of black cumin significantly (P ≤0.05) affected the pH-value of the braided cheese (Table 1). Sample containing 3.5% black cumin recorded the lowest pH-value (3.30%). Control sample (0.0% black cumin) showed the highest pH value (4.07%), while samples containing 0.5, 1.5 and 2.5% black cumin were at an intermediate position (pH values of 4.06, 3.67 and 3.55%), respectively.

The storage period significantly (P ≤0.05) affected the pH-value of the braided cheese (Table 2). The pH-value decreased gradually till the end of storage. The lowest value (2.82%) was obtained at the end of the storage period, while the highest (4.64%) was recorded at the beginning of the storage period.

The decrease in pH value of the samples may be due to an increase in titratable acidity (Koiskowski, 1982; El-koussy et al., 1995; Mahran et al., 2000; Abdel-Razig et al., 2001; El-Safty et al., 2004; Mohamed and Abdel-Razig, 2006; Ali and Abdel-Razig, 2011).

**Titratable acidity**

The levels of black cumin significantly (P ≤0.05) affected the titratable acidity of the braided cheese (Table 1). Cheese sample containing 3.5% black cumin recorded the highest titratable acidity (1.52%). Control sample (0.0% black cumin) showed the lowest (0.74%), while samples 0.5, 1.5 and 2.5% black cumin were at an intermediate position (0.86, 1.16 and 1.29%), respectively.

Storage period significantly (P ≤0.05) affected titratable acidity of braided cheese (Table 2). The titratable acidity increased gradually till the end of the storage period. The highest value (2.33%) was obtained at the end of the storage period (60 days), while the lowest value (0.17%) recorded at the beginning of the storage period.

It was found that black cumin added to tulum cheese sample had higher titratable acidity than other control cheese. The titratable acidity increased continuously until the end of ripening (Tarakci et al., 2004). It was found that, about 80-90% of the increase in acidity during storage of cheese was mainly due to the lactic acid formed by predominating lactic acid bacteria and to a lesser degree (10-20%) to the levels of black cumin (Abdel-Razig, 1996; Abdel-Razig and Al Gamry, 2009; Mahran et al., 2000; Tarakci et al., 2004).
**Total volatile fatty acid (TVFA)**

The levels of black cumin significantly (P ≤ 0.05) affected the total volatile fatty acid of the braided cheese (Table 1). Sample containing 3.5% black cumin recorded the highest total volatile fatty acid (74.91 mls 0.1N NaOH), and sample 0.0% black cumin the lowest (50.44 mls 0.1N NaOH), while samples 0.5, 1.5 and 2.5% black cumin were at an intermediate position (55.07, 60.83 and 66.33 mls 0.1N NaOH), respectively. Storage period significantly (P ≤ 0.05) affected the total volatile fatty acid of braided cheese (Table 2). The total volatile fatty acid increased gradually till the end of the storage. The highest TVFA value (86.10 mls 0.1N NaOH) was obtained at the end of storage (60 days), while the lowest TVFA (15.13 mls 0.1N NaOH) was recorded at the beginning of the storage period.

Abdel-Razig et al. (2002) mentioned that, the total volatile fatty acid of braided cheese increased during storage. The volatile fatty acids of chain length C2-C8 were reported to contribute to the cheese flavour (Harte and Stine, 1977; Omar et al., 1986). The improvement of cheese flavour was mainly attributed to the production of acid by lactic acid bacteria and levels of black cumin added (Koiskowski, 1982; Abdel-Razig, 1996; Mahran et al., 2000; El-Owni and Hamid, 2008).

**Formol ripening index (FRI)**

The levels of black cumin significantly (P ≤ 0.05) affected the formol ripening index of the braided cheese (Table 1). Cheese sample containing 3.5% black cumin recorded the highest formol ripening index (92.80%). Control sample (0.0% black cumin) showed the worst appearance (98.00%) at the beginning of the storage period. Tarakci et al. (2004) found that, the ripening indices ratio of tulum cheese sample had increased parallel to the level of black cumin added. The changes in FRI of braided cheese ran parallel to protein breakdown (El-Koussy et al., 1977; Mattere et al., 2000; Abdel-Razig et al., 2001).

**Organoleptic properties of braided cheese**

**Appearance**

The levels of black cumin significantly (P ≤ 0.05) affected the appearance of the braided cheese (Table 3). Cheese sample containing 1.5 % black cumin recorded the best appearance (4.26). Sample containing 3.5% level of black cumin showed the worst appearance (2.84) while the other levels of black cumin were at an intermediate position. The effect of black cumin addition (2.5% and 3.5%) rendered the cheese too dark and caused negative effect on appearance and color (Tarakci et al., 2004). Storage period significantly (P ≤ 0.05) affected the appearance of the braided cheese improved during storage (Abdel-Razig et al.
Table 1 Effect of levels of black cumin seeds (*Nigella sativa*) on biochemical composition of (Mudaffara) braided cheese.

<table>
<thead>
<tr>
<th>Item</th>
<th>0.0</th>
<th>0.5</th>
<th>1.5</th>
<th>2.5</th>
<th>3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH-value</td>
<td>4.07±0.02</td>
<td>4.06±0.05</td>
<td>3.67±0.01</td>
<td>3.55±0.06</td>
<td>3.30±0.04</td>
</tr>
<tr>
<td>Titratable acidity (as % lactic acid)</td>
<td>0.74±0.03</td>
<td>0.86±0.07</td>
<td>1.16±0.11</td>
<td>1.29±0.08</td>
<td>1.52±0.02</td>
</tr>
<tr>
<td>Total volatile fatty acids (mls 0.1N NaOH)</td>
<td>50.44±0.04</td>
<td>55.07±0.06</td>
<td>60.83±0.05</td>
<td>66.33±0.02</td>
<td>74.91±0.11</td>
</tr>
<tr>
<td>Formol ripening index (%)</td>
<td>20.31±0.09</td>
<td>50.20±0.04</td>
<td>58.40±0.01</td>
<td>74.60±0.03</td>
<td>92.80±0.05</td>
</tr>
</tbody>
</table>

*Mean± SD values having different superscript letters in rows are differ significantly (P ≤0.05).

Table 2 Effect of storage period on biochemical composition of (Mudaffara) braided cheese.

<table>
<thead>
<tr>
<th>Item</th>
<th>0.0</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH-value</td>
<td>4.64±0.02</td>
<td>4.20±0.09</td>
<td>3.72±0.11</td>
<td>3.28±0.03</td>
<td>2.82±0.07</td>
</tr>
<tr>
<td>Titratable acidity (as % lactic acid)</td>
<td>0.17±0.01</td>
<td>0.32±0.06</td>
<td>0.91±0.02</td>
<td>1.87±0.05</td>
<td>2.33±0.04</td>
</tr>
<tr>
<td>Total volatile fatty acids (mls 0.1N NaOH)</td>
<td>51.13±0.04</td>
<td>60.98±0.02</td>
<td>68.01±0.01</td>
<td>77.36±0.08</td>
<td>86.10±0.06</td>
</tr>
<tr>
<td>Formol ripening index (%)</td>
<td>22.00±0.09</td>
<td>52.00±0.01</td>
<td>62.00±0.04</td>
<td>82.00±0.03</td>
<td>98.00±0.06</td>
</tr>
</tbody>
</table>

*Mean± SD values having different superscript letters in rows are differ significantly (P ≤0.05).

Table 3 Effect of levels of black cumin seeds (*Nigella sativa*) on organoleptic quality of (Mudaffara) braided cheese.

<table>
<thead>
<tr>
<th>Item</th>
<th>0.0</th>
<th>0.5</th>
<th>1.5</th>
<th>2.5</th>
<th>3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>3.52±0.06</td>
<td>3.96±0.11</td>
<td>4.26±0.09</td>
<td>3.12±0.07</td>
<td>2.84±0.08</td>
</tr>
<tr>
<td>Texture</td>
<td>3.86±0.03</td>
<td>4.18±0.04</td>
<td>4.50±0.07</td>
<td>3.94±0.06</td>
<td>3.02±0.08</td>
</tr>
<tr>
<td>Flavour</td>
<td>4.24±0.09</td>
<td>4.36±0.08</td>
<td>4.60±0.07</td>
<td>3.34±0.08</td>
<td>3.10±0.03</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>4.20±0.07</td>
<td>4.34±0.08</td>
<td>4.54±0.11</td>
<td>3.52±0.04</td>
<td>3.16±0.06</td>
</tr>
</tbody>
</table>

*Mean± S.D values having different superscript letters in rows are differ significantly (P ≤0.05).
Hedonic scale (5: excellent, 4: very good, 3: good, 2: acceptable and 1: poor)

Table 4 Effect of storage period on organoleptic quality of (Mudaffara) braided cheese.

<table>
<thead>
<tr>
<th>Item</th>
<th>0.0</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>3.00±0.05</td>
<td>3.70±0.03</td>
<td>4.14±0.04</td>
<td>3.54±0.09</td>
<td>3.32±0.06</td>
</tr>
<tr>
<td>Texture</td>
<td>3.32±0.08</td>
<td>4.28±0.07</td>
<td>4.48±0.02</td>
<td>4.26±0.04</td>
<td>4.16±0.05</td>
</tr>
<tr>
<td>Flavour</td>
<td>3.52±0.03</td>
<td>4.10±0.01</td>
<td>4.32±0.05</td>
<td>4.00±0.07</td>
<td>3.70±0.09</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>3.68±0.04</td>
<td>4.12±0.08</td>
<td>4.26±0.04</td>
<td>4.04±0.06</td>
<td>3.66±0.05</td>
</tr>
</tbody>
</table>

*Mean± S.D values having different superscript letters in rows are differ significantly (P ≤0.05).
Hedonic scale (5: excellent, 4: very good, 3: good, 2: acceptable and 1: poor)
al., 2002; Mucchetti et al., 2002; Abd El-Rafee et al., 2004; Sameen et al., 2008).

Texture
The levels of black cumin significantly ($P \leq 0.05$) affected the texture of the braided cheese (Table 3). Sample containing 1.5% black cumin recorded the highest texture (4.50). Sample containing 3.5% level of black cumin produced the lowest texture (3.02) while sample 0.5%, 2.5% and 0.0% were at an intermediate position (4.18, 3.94 and 3.86), respectively. The body and texture properties in braided cheese had higher consistency than control cheese (Tarakci et al., 2004). Storage period significantly ($P \leq 0.05$) affected the texture of braided cheese (Table 4). The lowest value (3.32) was obtained at the beginning of the storage, while the highest (4.48) was recorded at the end of 30 days of the storage period. The Sudanese braided cheese needs only 30 days to mature and attain desirable culinary properties of texture (Abd El-Hamid et al., 2001; Abdel-Razig et al., 2002; Sameen et al., 2008).

Flavour
The level of black cumin significantly ($P \leq 0.05$) affected the flavour of the braided cheese (Table 3). Sample containing 1.5% black cumin recorded the highest flavour (4.60). Sample containing 3.5% level of black cumin recorded the lowest flavour (3.10) while samples 0.5%, 0.0% and 2.5% were at an intermediate position (4.36, 4.24 and 3.34), respectively. High levels of black cumin (2.5% and 3.5%) added to braided cheese resulted in bitter taste and aroma (Tarakci et al., 2004). Storage period significantly ($P \leq 0.05$) affected the flavour of the braided cheese (Table 4). The lowest value (3.00) was obtained at the beginning of the storage, while the highest value (4.14) was recorded at the 30 days storage period. The flavour of the white soft cheese was significantly ($P \leq 0.001$) improved during storage from day zero till day 120, then decreased in scores (Abdel-Razig et al., 2001; Hamid, 2005; Sameen et al., 2008).

Overall acceptability
The level of black cumin significantly ($P \leq 0.05$) affected the overall acceptability of the braided cheese (Table 3). Cheese sample containing 1.5% black cumin recorded the highest overall acceptability (4.54). Cheese sample containing 3.5% level of black cumin the lowest (3.16) while, samples 0.0%, 0.5 and 2.5% were at an intermediate position (4.20, 4.34 and 3.52), respectively. Level containing 3.5% black cumin added to braided cheese was the least preferred compared with control and other black cumin levels (Tarakci et al., 2004). Storage period significantly ($P \leq 0.05$) affected the overall acceptability of the braided cheese (Table 4). The least acceptable cheese sample was obtained at the end of the storage period (60 days) while samples stored for 30 days were judged highly acceptable. The overall acceptability of the braided cheese improved during storage period (Weatherup, 1986; Abdel-Razig et al., 2002; Mucchetti, et al., 2002; Sameen et al., 2008).

References


