Chemical, Sensory and Rheological Evaluation of Karish Cheese Made by Oyster Mushroom Mycelium

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ABSTRACT

Karish cheese was manufactured commercially by adding starter cultures and rennet. In this study, three species of Pleurotus mushroom mycelium were examined in making Karish cheese from skim buffalo’s milk. Yield, chemical, sensory and rheological properties of cheese manufactured by homogenized P. ostreatus (HPO), P. florida (HPF) and P. eryngii (HPE) were evaluated. Results showed decrease in the coagulation time by increasing the concentration of homogenized oyster mushroom mycelium. Karish cheese made by HPE resulted in the highest overall yield, followed by HPF, when compared with cheese manufactured by rennet, which had the lowest cheese yield. Chemical analysis illustrated that Karish cheese with homogenized Pleurotus mycelium was nearly of the same constitutional values, in addition to fiber. The rheological characteristics improved significantly in the fresh cheese samples made with HPO, HPF and HPE and during storage. Sensory evaluation showed that Karish cheeses made with HPO, HPF and HPE were more acceptable by the panelists than Karish made by starter or rennet.

Keywords: Karish cheese, Pleurotus mycelium, coagulation time, sensory and rheological properties.

INTRODUCTION

Karish cheese is the oldest varieties consumed in Egypt. The Egyptian consumer prefers this kind of cheese for its high protein content and low price. Karish cheese is made from skimmed cow’s milk, buffalo’s milk or a combination of both (Fahmi, 1960, Abou Donia, 2008, Osman et al., 2010 and Abd-El-Salam et al., 1984).

Any animal, plant or microbial enzyme which curdles milk called rennet (Sardinas, 1968). Milk clotting enzyme produced from the abomasums of unweaned calves has traditionally been used since precedent days as a coagulant in most cheese manufacturing. However, the decreasing number of slaughtered calves and increasing consumption of cheese led to an increased price of slaughtered calves and during storage. Sensory evaluation showed that Karish cheeses made with HPO, HPF and HPE were more acceptable by the panelists than Karish made by starter or rennet.

MATERIALS AND METHODS

Pleurotus strains (Pleurotus ostreatus MLCC 66, Pleurotus florida MLCC 14 and Pleurotus eryngii MLCC 555) were obtained from the mushroom cultivation and production unit at Central Laboratory for Agricultural Climate, A.R.C., Dokki, Giza, Egypt. Pure cultures of Lactobacillus bulgaricus and Streptococcus thermophilus were obtained from Hansen laboratories, Denmark. Standard microbial rennet powder (RENIPLUS 2000IMCU/g) was obtained from PROQUIGA BIOTECH, a certified company (Spain).

Fresh skim buffalo’s milk (0.5% fat, 4.46% protein) used in this study was obtained from The Hard of Animal Production Research Institute, Ministry of Agriculture, Sakha Experimental Station, Kafr El-Sheikh Governorate, Egypt.

Preparation of Pleurotus mycelia

The three strains of Pleurotus were prepared according to Wu and Hansen (2009) with slight modifications. Mycelia agar discs from the margin of eight-day-old colonies were isolated from the Potato dextrose (PD) agar culture by using inoculating loops. The mycelia agar
pellets were transferred to 250 ml flasks containing sterilized 100 ml PD broth with pH 6.0 (five discs per flasks) and incubated at 25°C ±1°C under aerobic conditions on rotary shaker (INNOVA, Model 4080, New Brunswick Scientific Co., INC. Edison New Jersey, USA) at 150 rpm. The biomass was homogenized in PD broth medium by hand blender (Mixxy, Type VO-022-k, 170w, Korea).

The coagulation time was detected during making cheese by incubation of milk by homogenized Pleurotus ostreatus (HPO), P. florida (HPF) and P. eryngii (HEP) with used concentrations of 0.5, 1.0, 1.5, 2.0 and 2.5%, and incubation at 42°C, followed by coagulation at 30 min intervals and at the end of coagulation (Chandrasekhara et al., 1957).

Karish cheese was made by the common procedure of Hamad (2015). Buffalo’s skim milk was heated to 90°C for 15 second and cooled to 40-45°C. The milk was divided into 5 portions, the first and second portions served as control A and B. Control A inoculated with 50g starter (10^-10cfu/g) and 0.005g rennet powder/100kg milk. Control B mixed with 0.01g rennet powder/100kg milk. Each of other three portions was mixed with 2.5% for each HPO, HPF or HPE. One percent sodium chloride (salt) were added to all portions and mixed well. Then the treated milk was incubated at 40-45°C until complete coagulation. After complete coagulation, the curd was pressed by suitable weights and left to drain overnight. The resulting cheese was cut into blocks, packed and stored at 5±2°C for 5 weeks.

The treated Karish cheeses were subjected to chemical, rheological properties and sensory evaluation when fresh and after 0, 7, 14, 21, 30 and 36 days of cold storage

Cheese yield % was determined according to the formula described by (Koca and Metin, 2004).

\[
\text{Cheese yield} = \frac{\text{amount of cheese (kg)}}{\text{amount of skimmed milk (kg)}} \times 100
\]

Moisture content, total solids (TS), fat (using Gerber method), and Fiber contents (hydrolyzed with 1.25% sulphuric acid and 1.25% sodium hydroxide to estimate crude fiber) were determined in Karish cheese treatments according to the methods described in A.O.A.C. (2005). Total nitrogen content of cheese was measured as described by Kjeldahl method (Ling, 1963). Total protein was calculated using factor of TN x 6.38.b All chemical measurements were prepared in triplicates.

Titratable acidity was estimated as given by Ling (1963). The results expressed as percentage of lactic acid.

Rheological analysis of cheese

Textural parameters of Karish cheeses were evaluated using a texture analyzer (CNS-Farnell, Borehamwood, Hertfordshire, England). Karish cheese samples were cut into cubes (20 mm in height and 30 mm in diameter) and kept at room temperature (20 ± 2°C) for 30–45 minutes prior to testing. The probe was TA 15 (30°C), at a speed of 1 mm/s and 10 mm distance, using cycle or normal programmers. Hardness (force required to attain a given deformation:N), adhesiveness (force required to pull probe from sample:J), springiness (cm), cohesiveness (the strength of internal bonds making up the body of the product: ratio), gumminess (hardness x cohesiveness: N), and chewiness (hardness x cohesiveness x springiness: J) were calculated as described by Szczesniak et al. (1963). The analysis was carried out three times.

Sensory evaluation

Ten panelists of staff members at Dairy Manufacturing Technology Research Department, (Food Technology Research Institute, Agriculture Research Center, Giza, Egypt), evaluated the sensory quality of Karish cheese after zero time, 7, 14, 21, 30 and 36 days of storage period. The products were evaluated for color & appearance (10 score), body & texture (30 score), flavor (40 score), odor (20 score) and total acceptability (100 score) according to method of Nelsons and Trout (1981).

The obtained data were statistically analyzed according to Steel and Torrie (1980). Analyses were outright with SPSS program version 16.0 (SPSS Inc., Chicago, IL, USA) the data were analyzed by one-way analysis of variance (ANOVA). Means separation was performed by Duncan’s multiple range tests. Differences at p<0.05 were considered as significant (Armitage and Berry 1987).

RESULTS AND DISCUSSION

Coagulation time of the commercial Karish cheese made by starter with rennet (control A) or rennet only (control B) were 120 and 180 min, respectively. Results indicated in Table 1 show the effect of using homogenized oyster mushroom mycelium at different concentrations on milk coagulation time during karish cheese making. Coagulation time decreased with increasing the concentration of homogenized oyster mushroom mycelium. The time of coagulation milk was shorter (150 min) when using 2.5% of HPO and HPE than 2.5% HPF (180 min).

Table 1. Milk coagulation time (min) with different concentrations of oyster mushroom mycelium

<table>
<thead>
<tr>
<th>Concentration, %</th>
<th>Pleurotus ostreatus</th>
<th>Pleurotus florida</th>
<th>Pleurotus eryngii</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>210±B</td>
<td>240±a</td>
<td>270±a</td>
</tr>
<tr>
<td>1.0</td>
<td>195±B</td>
<td>225±a</td>
<td>240±a</td>
</tr>
<tr>
<td>1.5</td>
<td>180±e</td>
<td>210±c</td>
<td>210±c</td>
</tr>
<tr>
<td>2.0</td>
<td>165±C</td>
<td>195±ad</td>
<td>180±d</td>
</tr>
<tr>
<td>2.5</td>
<td>150±6e</td>
<td>180±e</td>
<td>150±6e</td>
</tr>
</tbody>
</table>

In a raw, means having the same superscript capital letters are not significantly different at 5% level for storage period. In a columns, means having the same superscript small letters are not significantly different at 5% level for treatments.

Coagulation time increased in cheese made with rennet. Meanwhile, the coagulation time decreased when using starter mixed with rennet, which might be attributed to the increase in acidity (Table 2), which led to an increase in whey separation. These results were in agreement with Hamad (2015). Martim et al. (2017) who found that milk clotting enzymes from oyster mushroom Pleurotus albidus belong to cysteine protease.

Titratable acidity during coagulation of karish cheese samples

From the data of coagulation time, oyster mushroom mycelia at concentration 2.5% were selected to make karish cheese, compared with control A (made by 50g starter + 0.005g rennet/100kg milk) and control B (manufactured by 0.01g rennet/100kg milk). Table 2 illustrates no significant difference between all fresh karish cheese samples. The acidity ranged between 0.16- 0.17% at zero time.

Titratable acidity increased by increasing the coagulation time. Slightly significant increase in acidity was observed in all of the examined samples at the end time of the
coagulation, except in control A. It could also be noticed that cheese made by using mixture of starter and rennet was of higher acidity (0.8%) and shorter coagulation time (120 min), compared with the other examined samples. This might be attributed to the growth of the starter bacteria and produced lactic acid. Similar results were obtained by Abd El-Hamid (2016) for wheat bran supplemented karish cheese.

Table 2. Titratable acidity (%) during coagulation of karish cheese manufactured by different methods

<table>
<thead>
<tr>
<th>Karish samples</th>
<th>Coagulation time, min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zero</td>
</tr>
<tr>
<td>Control A</td>
<td>0.17a</td>
</tr>
<tr>
<td>Control B</td>
<td>0.17b</td>
</tr>
<tr>
<td>HPO</td>
<td>0.17b</td>
</tr>
<tr>
<td>HPE</td>
<td>0.16b</td>
</tr>
</tbody>
</table>

In a raw, means having the same superscript capital letters are not significantly different at 5% level for storage period. In a column, means having the same superscript small letters are not significantly different at 5% level for treatments. Control A = manufactured by starter + rennet, Control B = manufactured by rennet, HPO = 2.5% Homogenized Pleurotus ostreatus, HPE = 2.5% Homogenized Pleurotus florida, HPF = 2.5% Homogenized Pleurotus eryngii

Yield of karish cheese

Data indicated in Table (3) showed significant differences (P≤0.05) in the yield percentage of all cheese samples. The fresh yield of Karish cheese made by homogenized oyster mushroom mycelium (HFP, HPE and HPO), compared to make by starter and rennet (Control A) or by rennet only (Control B), Karish cheese made by HPE resulted in the highest overall yield (27.55%) followed by HPE (26.11), when compared with the control B, which had the least cheese yield (23.82%).

Table 3. Yield of karish cheese manufactured by different methods

<table>
<thead>
<tr>
<th>Karish samples</th>
<th>Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control A</td>
<td>24.55%</td>
</tr>
<tr>
<td>Control B</td>
<td>23.82%</td>
</tr>
<tr>
<td>HPO</td>
<td>25.50%</td>
</tr>
<tr>
<td>HPE</td>
<td>26.11%</td>
</tr>
<tr>
<td>HPF</td>
<td>27.55%</td>
</tr>
</tbody>
</table>

Yield of Karish cheese manufactured by different methods

Control A = 50 g starter + 0.005g rennet/100g milk, Control B = 0.01g rennet/100g milk, HPO = 2.5% Homogenized Pleurotus ostreatus, HFR = 2.5% Homogenized Pleurotus florida, HPE = 2.5% Homogenized Pleurotus eryngii

This increase in the karish cheese yield was associated with an increase in the cheese moisture content (Table 3). This indicated that the increase in yield might be due to the presence of fiber in karish cheese made by mushroom mycelium. Similar finding was previously found by other authors (Ahmed et al., 2005; Abd El-Hamid et al. (2016); Zayan, 2016; Basiony et al., 2018). Onwulata (2008) found that dietary fiber absorbed water from the environment. Also, the yield values of treatments were within the values reported by other researchers (Ibrahim et al., 1990 and Blassy and Ismail, 2003; Hamad, 2015).

Chemical analysis

Data in Table 4 show the effect of addition three types of homogenized mushroom mycelium at 2.5% on the chemical composition of karish cheese, compared with control samples. Slightly significant differences (P≤0.05) were obtained between control samples and other treatments when fresh and during storage period. Moisture content in control samples was 72.346% for control A and 71.661% for control B, while the other treatments had 72.850, 73.321 and 74.528% for HPO, HPF and HPE, respectively, at zero time. These results obviously increase in the moisture content of Karish cheese samples as a result of homogenized mycelium addition during the making cheese, compared with control samples; which might be due to the ability of the formed curd to retain moisture. On the other hand, these values decreased with prolonging of the storage period for all of the treated samples. At the end of storage period, the moisture values decreased to be 68.958, 68.608, 70.187, 70.868 and 72.084% for control A, control B, HPO, HPF and HPE, respectively, after 36 days storage. These results agree with Youssef et al. (1981). Decrease of moisture content in Karish cheese samples with advancing of the storage period as a result of removing some whey from the stored samples in a refrigerator (Abo Sharaa, 2017). Total solids contents increased gradually during storage, reaching the maximum at the end of storage period. This increase might be due to the loss of moisture during cold storage, and to the increase of acidity which accelerates whey syneresis (Basiony et al., 2018).

Results in the same Table also show that protein and fat contents of cheese increased in the presence of mycelium addition in HPO, HPF and HPE karish cheese, compared with the control samples. Protein content was the highest in control A (21.754%), followed by cheese with HPO and HPF (21.588 and 21.020%, respectively), which might be due to the decrease in the moisture content in the control samples. Fat content in fresh HPO and HPF samples were also of the highest (1.683 and 1.537%, respectively). The increase in fat content in cheese made by HPO, HPF and HPE might be due to the high content of mycelium fat. Fiber content in fresh cheese manufactured by HPF was higher (0.931%) than cheese with HPF (0.649%) or HPO (0.625%) due to the high content of mycelium fiber compared with control samples, which do not contain fibers (Table 4).

On the other hand, protein, fat and fiber content were increased with progression of storage period for all treatment samples. The increase in these values content between samples might be due to the decrease of moisture content in karish cheese during storage period. These results were in agreement with those of Saleh (2018) who mentioned that the protein and fat content were increased in all samples during storage.

Texture profile analysis of karish cheese samples

Texture is defined as the sensory manifestation of food structure and the way in which this structure reacts to the forces applied, represents the junction of all the mechanical, geometric and superficial attributes of a product, sensed through mechanical, tactile, visual and hearing receptors (Szczesniak et al., 1963).

At zero time, figure 1 clarified that control B cheese samples had a significantly higher hardness value (6.5 N) than other samples followed by control A (5.6 N). Low hardness was observed in cheese samples made by homogenized oyster mushroom mycelium. These observations may be due to the presence of fiber and more moisture content in these samples. The hardness value was increased gradually by increasing the storage period for all the karish cheese samples, resulting from the loss of the moisture throughout the storage period (Delgado et al. 2011).
Adhesiveness takes the same trend in the changes of the hardness (Korish and Abd-Elhamid, 2012). Adhesiveness of control B cheese sample reported the highest value (1.04 mj) at zero time. The adhesiveness values of other cheese samples were approximately similar. The values ranged between 0.86 mj for control A to 0.76 mj for HPE sample.

During cold storage for 36 days, adhesiveness values were increased (Korish and Abd-Elhamid, 2012). Bryant et al. (1995) reported that decrease in fat and dry matter content resulted in decrease in adhesiveness of the cheese. However, the opposite result was found in previous study by Karaman and Akalın (2013).

**Table 4. Chemical composition (%) of karish cheese samples during storage period**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Storage period, day</th>
<th>Moisture</th>
<th>Protein</th>
<th>Fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>7</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Control A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
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In a row, means having the same superscript capital letters are not significantly different at 5% level for storage period. In a column, means having the same superscript small letters are not significantly different at 5% level for treatments. Control A = 50 g starter + 0.005g rennet/100kg milk, Control B = 0.01g rennet/100kg milk, HPO = 2.5% Homogenized *Pleurotus ostreatus*, HPF = 2.5% Homogenized *Pleurotus florida*, HPE =2.5% Homogenized *Pleurotus eryngii*

Chewiness is a measure of the work needed to masticate a solid food to a state ready for swallowing (Tunick, 2000), which, in sensory terms, was the number of chews that are required before the sample is ready for swallowing (Gwartney et al., 2004). Low-fat cheese samples had high chewiness values while high-fat or high-moisture ones had low chewiness.

Factors affecting the hardness and cohesiveness of the sample also affect the gumminess (Goksel et al. 2013). A similar behavior was observed in the chewiness, which is equivalent to the energy required for the mastication of the sample before swallowing (Huang et al. 2007). The relation between gumminess and chewiness is in agreement with the study of Karaman and Akalın (2013).

Springiness value of karish cheese manufactured by homogenized oyster mushroom mycelium was higher than control A and B (Figure 1). Springiness results are consistent with Korish and Abd-Elhamid (2012) who reported that the springiness value of karish cheeses with hydrocolloids was higher than that of the control. Springiness values decreased during storage period, which might result from the slight increase in fat content of the samples. Tunick et al. (1993) reported that fat found in the sample decreases the elasticity of the protein network.

Cohesiveness is a measure of the deformation of cheese before it breaks (Karaman and Akalın, 2013). Generally, cohesiveness decreases with increase in storage period. There are both similar and different results in the literature relating to the interaction of cohesiveness and chemical composition, although a positive correlation was found between the dry matter content and cohesiveness (Koca and Metin 2004). Delgado et al. (2011) determined a negative correlation between those two parameters. Moreover, a negative correlation between the fat content and cohesiveness was observed in another study (Bryant et al., 1995). The cohesiveness, adhesiveness, and springiness values of all the cheeses indicated slight differences in these characteristics of all the cheese samples (Figure 1).
Sensory evaluation

Sensory analysis of Karish cheese samples was evaluated for odor, flavor, body & texture, color & appearance and total acceptability. The mean scores for all sensorial properties of cheese samples are presented in Table 5. Data analysis indicated that, there were no significant differences between all fresh karish cheese samples in odor and color & appearance. Fresh control A and cheese with HPF had the highest score of odor (39.6 and 39.0, respectively), but control B had the least (37.4). Mean score of body & texture was the highest in control A (30) followed by cheese with HPF and HPO (29.5 and 29.0, respectively). Acceptability of all fresh cheese samples had high score. Mean values for score of acceptability ranged between 99.6 for control A and 94.7 for control B. Acceptability of fresh cheese with HPF was higher (97.2) than cheese with HPO (96) or HPE (95.7).

CONCLUSION

Karish cheese manufactured by oyster mushroom mycelium resulted in the highest overall yield, moisture, protein, and fiber. The rheological characteristics improved significantly in cheese samples. Also, sensory evaluation was more accepted by the panelists compared to control samples. From these results, it is possible to use the Pleurotus mycelia as substitute rennet enzyme in manufacturing of karish cheese.

REFERENCES


