QUALITY OF KAREISH CHEESE TREATED BY TRANSGLUTAMMINASE

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ABSTRACT

Kareish cheese was manufactured by using L.c.Lactis ssp lactis with Transglutaminase (TGase) at levels of 0.00, 0.02, 0.03 and 0.04 %, stored in refrigerator at 5°C±1 for three weeks and examined periodically for chemical, microbiology and sensory properties. Protein fractionation profiles and microstructure were also studied. TGase treated fresh cheese gave higher yield and moisture contents and lower acidity value than the control. A minor decline of total bacterial viable count was found in cheese treated samples compared to the control one after one week of cold storage. Contaminating non-starter microorganisms (i.e., coliforms, yeasts & moulds) were not found in treated cheese samples during the 3-weeks of cold storage.

SDS-PAGE analysis showed clear differences in protein patterns and bands between the control and cheese treated with TGase. TGase caused aggregates of some proteins in β-casein region, increasing the TGase level led to more aggregates. Scanning electronic microscope showed that the use of TGase had a clear remarkable effect on the cheese protein matrix when compared to control cheese. Kareish cheese treated with TGase had a more compact structure and fine creamy gel texture.

The higher score of sensory evaluation was recorded for the higher levels of TGase treated cheese. Increasing the level of TGase increased the improvement of body and texture. It could be concluded that a good quality Kareish cheese could be made from milk treated with 0.04% TGase in order to maintaining the good body and texture. Moreover treated the cheese milk with TGase led to a product with pleasant consistency and mouth feeling.

Keywords: Transglutaminase, kareish cheese, yield, microstructure.

INTRODUCTION

Kareish cheese is an acid dairy product which is widely used in Egypt. It is a white, soft cheese containing about 70% moisture and not more than 10% fat, and is made from sour milk, either laban rayeb or buttermilk. Skim milk, fresh or slightly fermented, is also used at commercial scale for its manufacture in small dairy plants. Meanwhile, it becomes very popular because of its remarkable health quality as the only known fat free cheese consumed by the Egyptians (Hofi et al., 2004). Kareish cheese made from laban rayeb is generally much better in quality and has a better flavor than that made from butter milk, which in turn is better than that made from skim milk. This can be attributed to favorable fermentations which may take place in milk during setting and to the higher fat content of laban rayeb compared to the other two products. The chemical composition of Kareish cheese varies from sample to sample, depending on the type of material used in cheese manufacture, and is as follows: moisture, 69.0%; total solids, 31.0%; protein, 17.0%; fat, 6.0%;
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other organic materials, 0.2%; ash, 0.6%; salt, 4.5%; calcium, 0.2% and phosphorus 0.24% (El-Gendy, 2001).

Three-dimensional network of cheese is mainly linked together by physical cross-links, like hydrophobic interactions, van der Waal forces, hydrogen bonds and electrostatic interactions. These links are rather week and flexible compared to chemical cross-links, with permanent covalent bonds (Dickinson, 1997). Transglutaminase (TGase) is a protein-glutamine: amine y-glutamyltransferase, which catalyses reactions, which could render coporation of an amide to the peptide chain or a protein cross-linking. Cross-linking reactions results in the formation of dimmers, trimmers and larger protein polymers. Without any interference, cross-linking will continue until glutamines or lysines become unavailable to the enzyme. The use of TGase in dairy products is so far only in the experimental stage, but there seems to be many applications results generally in products with higher strength and lower permeability and syneresis (Faergemand and Qvist 1997; Lauber et al., 2000; Lorenzen et al., 1999; Nonaka, et al., 1992; Abou El-Nour et al., 2004). In the area of cheese production, TGase treatments can reduce cheese losses, improve water retention in reduced fat cheese and in turn increasing cheese yield, improve cheese quality and strongly improved the Body and texture of the cheese (Loranzen et al., 2002 and Han et al., 2003). TGase can be used in stabilizing products like yoghurt, fresh cheese, whipping cream and novel milk products (Lorenzen et al., 2000; Abou El-Nour et al., 2004 and Mieko et al., 2004).

The aim of the present study was to investigate the possibility of improving the overall quality of Kareish cheese i.e. yield, microstructure and keeping quality by using TGase as a protein cross-linking enzyme.

MATERIALS AND METHODS

Materials

Milk: Buffalo’s milk was obtained from Faculty of Agriculture, Suez Canal University and skimmed in Diary Science Department.

TGase: transglutaminase was obtained from Ajinomoto Europe Sales (Stubbenhuk 3, D-20459, Hamburg, Germany); the declared activity of the preparation was approximately 100 units/g.

Starter culture: Lactococcus lactis ssp. lactis (DSM 90501) was obtained from the culture bank of the institute of microbiology BFEL, Kiel, Germany.

Methods

Kariesh cheese Manufacture:

Kareish cheese was processed as shown in Figure (1). Resultant cheese was packed into plastic containers and stored in refrigerator at 5 ±1°C for three week. Samples were taken periodically after 24 hr (fresh), 1, 2 and three weeks. Whole experiments were repeated three times and the results are average of three replicates.

Chemical analysis:

Fat, total and soluble nitrogen, dry matter, was analyzed by standard methods of Marshall, (1992). Cheese samples were checked for pH using
(Jenway pH meter electrode No. 29010, Jenway limited, England). The cheese yield was recorded as kg of cheese/100kg of cheese milk. Sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE 15%) was performed by the method of Laemmli (1970). The proteins contained in cheese samples treated with or without TGase, was performed. The densitometric analysis of the stained bands was performed using the Gel Docu-Advanced Program (El-Manar Co. Cairo, Egypt).

Skim milk (0.5% fat, 9% SNF)

↓

Pasteurization at 72 °C/2min, Cooling to 40 °C

↓

Addition of TGase at levels of 0.00, 0.02, 0.03, and 0.04% and incubation at 40 °C /2h

↓

Inactivation of enzyme at 80 °C / 1min and cooled to 35 °C

↓

Addition of starter (2%) incubating at 35 °C till coagulation

↓

The resulting curd scooping into wooden frames lined with cheesecloth's

↓

Salt is sprinkling on the curd when it is firm enough

↓

Cuting into equal parts, stored at 5 °C±1 for three weeks

Fig (1): Flow diagram for the production of TGase treated Kareish cheese

Microbiological analysis:
Cheese samples were analyzed for total bacterial count using skim milk agar medium, for coliform count using McConkey agar medium as recommended by the American Public Health Association (1978), and for yeast & moulds count using YM agar medium (Merck).

Scanning Electron Microscopy (SEM) analysis:
Scanning electron microscopy studies were carried out by Etching method, which performed according to Reimer (1985). Cheese Samples
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were cut to small right angle pieces, fixed with 3% glutaraldehyde for three hours, dehydrated with serial concentration of acetone, then critical point dried and spotted with gold for identification by "SEM". All specimens were observed with a SEM (Jeol T330A, Japan) and the images were taken at 15KV according to Reimer (1985).

Organoletic assessment:
The sensory evaluations were assessed by the staff of the Dairy Department, Suez Canal University using the following scale for flavour, (40 points) and body and texture (60 points) according to Han (2003).

RESULTS AND DISCUSSION

Chemical composition of the whey obtained from Kareish cheese treated with different levels of TGase

Table (1) reveals total solids (TS), total nitrogen (TN), total protein (TP) contents, acidity and pH of whey drained from cheese of different treatments as affected by TGase levels. Results cleared that TS obtained form whey gradually decreased as the level of TGase increased. Also, TN and TP contents decreased in the recovered whey with increasing dosage of TGase compared to control. These results coincided with those of Han et al., 2003 and El-Kholy, 2005; they reported that the decreased protein content in recovered whey is caused by the cross-linking of some of whey proteins to the cheese proteins by TGase. Slight differences were observed on acidity and pH of whey, acidity decreased with increasing the level of TGase, pH values had an opposite trend of acidity of the corresponding drained whey.

Table (1): Chemical composition of the whey obtained from Kareish cheese treated with different levels of TGase

<table>
<thead>
<tr>
<th>Treatments</th>
<th>TS (%)</th>
<th>TN (%)</th>
<th>TP (%)</th>
<th>pH</th>
<th>Acidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>13.21</td>
<td>0.174</td>
<td>1.11</td>
<td>4.44</td>
<td>0.64</td>
</tr>
<tr>
<td>T1</td>
<td>12.87</td>
<td>0.152</td>
<td>0.996</td>
<td>4.50</td>
<td>0.62</td>
</tr>
<tr>
<td>T2</td>
<td>12.78</td>
<td>0.149</td>
<td>0.950</td>
<td>4.52</td>
<td>0.61</td>
</tr>
<tr>
<td>T3</td>
<td>12.74</td>
<td>0.146</td>
<td>0.931</td>
<td>4.53</td>
<td>0.60</td>
</tr>
</tbody>
</table>

T0: Whey obtained from Kareish cheese containing 0.00 % TGase (control)
T1: Whey obtained from Kareish cheese containing 0.02 % TGase
T2: Whey obtained from Kareish cheese containing 0.03 % TGase
T3: Whey obtained from Kareish cheese containing 0.04 % TGase
TS: total solids; TP: total protein; TN: total nitrogen

Yield and gross composition of TGase treated Kareish cheese.

Yield:

Data gave in Table (2) indicate that TGase treated fresh cheese gave higher yield than the control. This may be attributed to higher moisture content in the former than in the latter. Lorenzen and Schlimme, 1998 reported that TGase treatments increase the water binding capacity of cross linked protein. And could be attributed to whey protein retained in cheese curd. These results are in accordance with those given by Budtz, 2001 and El-Kholy, 2005 they reported that TGase increased the amount of protein left in the coagulated cheese material as compared to cheese made without
TGase. Budtz, 2001 and Han, et al., 2002 stated that TGase treated cured contained smaller protein particles with less empty space which reduced syneresis. The yield was increased with the increasing TGase level. Prolonged storage decreases the yield for all cheeses mainly due to the loss in moisture.

Acidity and pH:
It was noticed that TGase treated cheese had relatively low titratable acidity values than control which can be attributed to TGase capable to catalyzing the diaminidation of glutamine residues where by water is used as nucleophil and ammonia liberated (Ikura et al., 1980; Lorenzen and Schlimme, 1998) also O’ Sullivan, et al., (2001); Abou El-Nour, et al., (2004) and El-Kholy, (2005) reported that the development of pH in products made from TGase treated milk was slower than control treatments. In addition, acidity of all samples increased gradually a long the cold storage to rich maximum values after 21 days. Similar observations were reported by (Abdel Kader, 2003; Salama, 2004 and El-Kholy, 2005).

The change in pH values were negatively related to the changes of acidity. Fresh cheese samples had pH values ranged from 4.56 to 4.63, in the 7th day of storage, the pH did not change and after 21 days the pH dropped slightly to 4.47-4.54. Hence, the pH of the cheese remained almost stable (= 4.5) during the 21 days of storage which could be attributed to high buffering capacity of cheese proteins (Kailasapathy et al., 1996 and Abbas et al., 2006) reported similar results for yoghurt.

Total solids content:
The data presented in Table (2) show an increase in the TS content of the control than TGase cheese. This could be attributed to the considerable increase in water binding capacity of cross linked protein in cheese treated with TGase (Lorenzen and Schlimme, 1998). The TS content of cheese from all treatments increased as storage period progressed due mainly to the decrease of moisture content.

Nitrogen content:
Cheese milk treated with TGase led to an increase in the TN/TS content compared to control cheese and these were proportional to the amount of added TGase. These results are in accordance with those given by (Budtz, 2001 and El-Kholy, 2005), they reported that TGase increased the amount of protein left in the coagulated cheese material as compared to cheese made without TGase. The TN contents of all samples increase throughout storage due mainly to the decrease in moisture content (Ezzat, 1990). On the other hand SN/TN decreased in cheese treated with TGase, this may be due to cross linking reactions between protein-protein, peptide-protein and amino acid-protein results in the formation of dimmers, trimmers and larger protein polymer Neve et al., (2001). Further decrease in SN/TN of Kareish cheese was obtained by increasing the level of TGase added. In all samples the SN increased as storage progressed.

Microbiological properties
Results given in Fig (2) indicated that Kareish cheese made from milk treated with TGase (T3 and T4) had a slightly higher total count (TC) than other treatments when fresh and after 7 days of storage. A slightly decreased
in the total count was observed in T1, T2 and T3 than control during storage. However, the increase the addition of TGase at percentage ranged from 0.02 to 0.04 led to decrease in the total viable count during storage period. This may be due to cross linking reactions between protein-protein, peptide-protein and amino acid-protein results in the formation of dimmers, trimmers and larger protein polymer (Neve et al., 2001), which cause shortage of some growth factors.

Table (2): Yield and gross composition of TGase treated Kareish cheese.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Age (days)</th>
<th>Yield (%)</th>
<th>Acidity (%)</th>
<th>pH</th>
<th>TS (%)</th>
<th>SN (%)</th>
<th>TN (%)</th>
<th>SN/TN (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>Fresh</td>
<td>19.21</td>
<td>1.29</td>
<td>4.56</td>
<td>27.90</td>
<td>0.29</td>
<td>2.37</td>
<td>12.23</td>
</tr>
<tr>
<td>T1</td>
<td>7</td>
<td>23.92</td>
<td>1.25</td>
<td>4.60</td>
<td>25.92</td>
<td>0.25</td>
<td>2.36</td>
<td>10.77</td>
</tr>
<tr>
<td>T2</td>
<td>24.12</td>
<td>1.22</td>
<td>4.61</td>
<td>25.88</td>
<td>0.25</td>
<td>2.30</td>
<td>10.86</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>24.19</td>
<td>1.21</td>
<td>4.63</td>
<td>25.80</td>
<td>0.24</td>
<td>2.32</td>
<td>10.61</td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>7</td>
<td>18.71</td>
<td>1.34</td>
<td>4.53</td>
<td>28.60</td>
<td>0.33</td>
<td>2.40</td>
<td>13.75</td>
</tr>
<tr>
<td>T1</td>
<td>23.56</td>
<td>1.28</td>
<td>4.60</td>
<td>26.20</td>
<td>0.26</td>
<td>2.40</td>
<td>10.83</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>23.89</td>
<td>1.25</td>
<td>4.60</td>
<td>26.32</td>
<td>0.26</td>
<td>2.35</td>
<td>11.06</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>24.10</td>
<td>1.23</td>
<td>4.61</td>
<td>26.40</td>
<td>0.25</td>
<td>2.33</td>
<td>10.72</td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>14</td>
<td>18.52</td>
<td>1.49</td>
<td>4.51</td>
<td>28.70</td>
<td>0.38</td>
<td>2.45</td>
<td>15.51</td>
</tr>
<tr>
<td>T1</td>
<td>23.11</td>
<td>1.32</td>
<td>4.58</td>
<td>26.30</td>
<td>0.29</td>
<td>2.50</td>
<td>11.60</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>23.52</td>
<td>1.29</td>
<td>4.59</td>
<td>26.40</td>
<td>0.28</td>
<td>2.47</td>
<td>11.33</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>23.77</td>
<td>1.24</td>
<td>4.60</td>
<td>26.50</td>
<td>0.26</td>
<td>2.40</td>
<td>10.83</td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>21</td>
<td>18.33</td>
<td>1.64</td>
<td>4.47</td>
<td>28.70</td>
<td>0.43</td>
<td>2.47</td>
<td>17.40</td>
</tr>
<tr>
<td>T1</td>
<td>22.85</td>
<td>1.42</td>
<td>4.49</td>
<td>26.35</td>
<td>0.33</td>
<td>2.52</td>
<td>13.09</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>23.00</td>
<td>1.41</td>
<td>4.52</td>
<td>26.41</td>
<td>0.32</td>
<td>2.54</td>
<td>12.59</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>23.22</td>
<td>1.37</td>
<td>4.54</td>
<td>26.52</td>
<td>0.29</td>
<td>2.60</td>
<td>12.23</td>
<td></td>
</tr>
</tbody>
</table>

T0: Kareish cheese containing 0.00 % TGase (control)
T1: Kareish cheese containing 0.02 % TGase
T2: Kareish cheese containing 0.03 % TGase
T3: Kareish cheese containing 0.04 % TGase

During storage total count of all treatments gradually decreased, this may be due to the effect of the acidity on the different microbial groups (Hammer and Babel 1957).

Coliform bacteria and yeasts & molds were not detected in 1.0 g of TGase Kareish cheese when fresh and during the first two weeks of storage period in all treatments as the results of high hygienic conditions during manufacturing and storage. However, a few amounts of yeast and moulds counts were observed in the control cheese at the end of storage.
Fig (2): Changes in Total viable count of TGase treated Kareish cheese when fresh and during storage at 5°C ±1 for 21 days. *See table (2) for samples designation

Table (3): Coliform bacteria and yeasts & moulds total viable count (x 10^3 cfu/g) of Kareish cheese treated with TGase during storage period.

<table>
<thead>
<tr>
<th>Treatments/Time (days)</th>
<th>E. coli</th>
<th>Y&amp;M</th>
<th>E. coli</th>
<th>Y&amp;M</th>
<th>E. coli</th>
<th>Y&amp;M</th>
<th>E. coli</th>
<th>Y&amp;M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>7</td>
<td>14</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
</tr>
<tr>
<td>T1</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
</tr>
<tr>
<td>T2</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
</tr>
<tr>
<td>T3</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
<td>N.D</td>
</tr>
</tbody>
</table>

*See table (2) for samples designation
Y&M: Yeast & Moulds
ND: Not Detected

SDS-PAGE profiles analysis of cheese samples treated with TGase.
Analysis for SDS electrophoretic patterns of fresh Kareish cheese samples made with different levels of TGase are presented in Fig (3) and Table (4). Analysis of all samples seemed to be divided into four regions, k-casein (in slow moving region) β-casein, α-casein and the fast moving region as monitored by El-Shibiny (1978) and Mahran et al., (1988). SDS-PAGE analysis of all samples shows differences in density and intensity of all protein bands in all treatments and control. Protein aggregates in Kareish cheese treated with TGase was higher when compared to control. The highest aggregation in bands density and intensity were found in β-casein region. On the other hand the lowest aggregates in bands density and intensity were observed in control. Increased the level of TGase led to more aggregates of proteins in β-casein region.
Fig (3): SDS-PAGE analysis of fresh Kareish cheese treated with TGase.
Lane 1: Low molecular weight protein marker; Lane 2: Kareish cheese treated with 0.00% TGase (control); Lane 3: Kareish cheese treated with 0.02% TGase; Lane 4: Kareish cheese treated with 0.03% TGase; Lane 5: Kareish cheese treated with 0.04% TGase Lane 6: Sodium caseinate reference.

Table (4): Analysis of SDS-PAGE of fresh Kareish cheese treated with TGase.

<table>
<thead>
<tr>
<th>Band</th>
<th>Mol.Wt* kDa</th>
<th>Lane 2</th>
<th>Lane 3</th>
<th>Lane 4</th>
<th>Lane 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100-105</td>
<td>23.74</td>
<td>14.18</td>
<td>19.98</td>
<td>14.03</td>
</tr>
<tr>
<td>2</td>
<td>55-70</td>
<td>32.14</td>
<td>48.85</td>
<td>50.29</td>
<td>57.07</td>
</tr>
<tr>
<td>3</td>
<td>10-14</td>
<td>31.26</td>
<td>25.95</td>
<td>21.95</td>
<td>22.45</td>
</tr>
<tr>
<td>4</td>
<td>6-7</td>
<td>12.86</td>
<td>11.04</td>
<td>7.78</td>
<td>6.46</td>
</tr>
</tbody>
</table>

See Fig (3) for samples designation
*Mol.Wt: molecular weight

Scanning Electron Microscopy (SEM) analysis of Kareish cheese samples

The SEM of Kareish cheese samples treated with different levels of TGase are presented in Figures (4: a, b, c and d). The TGase treated cheese appeared to have a more compact structure compared to control one. Using TGase formed a delicate and fine creamy gel texture. On the other hand, control made using starter culture only without TGase associated with whey separation forming round voids and resulting contraction in smaller masses of casein aggregates with a more porous structure and nonreflecting zones around the compressed casein aggregate. As illustrated, casein appeared as large micelle aggregates separated by non reflective black space. A slight difference between the microstructure of TGase treated cheese can be detected. Increased
homogenous distributed clusters and continues microstructure were evident. Therefore, it could be noticed that the separated clusters or particles had positive effect and gave better closed tied microstructure.

Fig (4: a, b, c and d): Scanning Electron Microscopy (SEM) analysis of TGase treated Kareish cheese samples
a: is control cheese (0.00 % TGase);b, c and d are Kareish cheese treatments treated with TGase (0.02, 0.03 and 0.04 %), respectively.

Organoleptic properties
Table (3) represents the average results of the sensory evaluation of the Kareish cheeses. It was noticed a slight difference in flavour score between fresh control and TGase treated cheeses. All cheeses were accepted for flavor by panelists. Prolonged storage improved flavour of all cheeses, but it was more pronounced for TGase cheeses. TGase treatments improved the body and texture of fresh cheese, the cheese had a soft curd and smooth body with no holes. TGase treated cheese had higher scores for body and texture compared to control. Increasing
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the level of TGase added increased the improvement of body and texture. The best cheese quality was that made by adding 0.04% TGase. The results are in agreement with those of many investigators (Loranzen et al., 2002; Han et al., 2003; Abou El-Nour et al., 2004 and El-Kholy, 2005), they reported that the texture of the products improved by TGase cross linking. Prolonged storage increase body and texture scores for all TGase treated samples. However, the body and texture score for control samples decreased during storage.

From the foregoing results it could be concluded that good quality Kareish cheese could be made from milk treated with 0.04% TGase in order to maintaining the good body and texture. Moreover treated milk cheese by TGase led to a product with pleasant consistency and mouth felling.

Table (5): Sensory properties of TGase treated Kareish cheese when fresh and during storage at 5°C±1 for 21 days.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fresh</th>
<th>Storage period (days)</th>
<th>7days</th>
<th>14 days</th>
<th>21days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B&amp;T (60)</td>
<td>Fl (40)</td>
<td>Total (100)</td>
<td>B&amp;T (60)</td>
<td>Fl (40)</td>
</tr>
<tr>
<td>T0</td>
<td>50</td>
<td>32</td>
<td>82</td>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>T1</td>
<td>51</td>
<td>33</td>
<td>84</td>
<td>53</td>
<td>35</td>
</tr>
<tr>
<td>T2</td>
<td>53</td>
<td>33</td>
<td>86</td>
<td>54</td>
<td>36</td>
</tr>
<tr>
<td>T3</td>
<td>56</td>
<td>33</td>
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<td>58</td>
<td>37</td>
</tr>
</tbody>
</table>

B&T: Body and Texture; Fl: Flavour
*See table (2) for samples designation

REFERENCES


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تأثير استخدام إنزيم التراناس جلوتاميناز على جودة الجبن الفرشي
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يوجد إنزيم الترانس جلوتاميناز في الطيور، وقد أظهرت الدراسات أنه ينخفض
الكائنات الحية. ولذا النظام القطرة على طريقة تتعلق ببعضها أو ربط البروتينات بالأحماض الأمينية
 مما يزيد من خواص البروتينات الزيتية وتحسين القيمه الغذائية والرطوبة والمحتوى والتصانيف للمنتج.
وفي هذا البحث تم استخدام هذا الإنزيم في صناعة الجبن الفريش حيث تم cámara مع معاليمات،
وهي: تُسمى اسم إنزيم (0.200, 0.400) فضلاً عن التكرير، و.uk تكريرات الجبن الناتج على مدة 4
أرياح conducts temperature 5°C و 1.5°C. و، إجراء التحاليل الكيماوية ويميولوجية ومسحية، وإذ تم دراسة التركيب البشري للجبن الناتج
بالميكروسكوب الإلكتروني، وشفاء البروتينات المختلفة بالجرد في المجال الكربوني.
وقد زادت تضافر الجبن الماستر إل ازيل وارتفاع المحتوى الرطبي به عن الجبن غير معامل.
لظهرت الدراسات الميكروبيولوجية أن الجبن معامل أحسن على عدد ميكروبات أقل بعد استخدام
من التخزين، كذلك لم يظهر أي ثلوث ناتج عن الفطريات أو البكتيريا وتكريرات طوال مدة
التخزين.

تحليل

البروتين والكائنات بين الجبن المعامل بالإنزيم وبدون الكترون، كذلك وجد أن زيادة تركيز الإنزيم لدى
0.200 و 0.400، أظهرت النتائج المحتملة على ذلك، منخفض إنزيم β-casein إلى تأثير واضح خاصة في منطقه
البانيا الدقيق بالميكروسكوب الإلكتروني الماسي (SEM) وجود اختلافات في التركيب البشري بين
الجين المصنوع باستخدام إنزيم بإنزيم جسة Tgase Gase
و، إجراء التحاليل الكيماوية، حيث تشير إلى تركيب الجبن معامل جيدة في معامل المعاليم، وهذا حسب على أن
زيادة تركيز الإنزيم أدت إلى تحسن واضح في الشكل البشري للجين المعامل عليه.
أظهرت التنقيحات الحمضية موجة الجبن الفريش المعامل بالإنزيم على تقديرات أعلى بالنسبة
اللحم والبقول، ولم تكن زيادة نسبة الإنزيم أظهر تأثير واضح على هذه الخواص.
وهكذا أمكن تسمية في جبن الفريش من صفات جيدة كيميائية، نباتية، تكنولوجية وحمضية عالية
والفروج من ممارسات تأهيل ووصول مقبول باستخدام الزيم الترانس جلوتاميناز حتى تركيز
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