

Research Article

Improvement of Domiaty Cheese Properties Using Cichorium and Bromelain Extracts

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Abstract

Background and Objective: Cichorium and bromelain extracts considered a good source for enhancing of cheese ripening without appear off-flavour in final product in case of added during cheese making in specific proportion, therefore the present study was applied the foregoing plant extracts to enhance of Domiaty Cheese Properties. **Materials and Methods:** Fat content of buffalo's milk was reduced to 4% fat, both bromelain and cichorium were extracted according to official methods. Experimental Domiaty cheese has been carried out. Physicochemical and biochemical properties of Domiaty cheese were determined according to the official methods. **Results:** No significant ($p>0.05$) differences were noticed in the moisture and salt contents and salt/moisture ratio of cichorium and bromelain samples as compared with control samples, while the significant ($p<0.05$) decreases in moisture content of all treatments were observed during the storage days, in contrast the significant ($p<0.05$) increases in salt content has been occurred with the storage. The total nitrogen (TN) and TN/dry matter (DM) ratio exhibited significant ($p<0.05$) differences between control and other cheese samples, also these parameters had significant ($p<0.05$) increases as the storage time proceeding. The significant ($p<0.05$) decreases in pH values of Domiaty cheese were noticed compared with controls. During the storage periods, the pH values were decreased for all cheese samples. All ripening indices of control samples were less than other treatments. The ripening indices of cheese significantly ($p<0.05$) increased as the storage periods proceeding. Cheese treatments were acquired high sensory evaluation scores concurrently with the increase of the plant extracts to the pickling solution compared to their addition before renneting step, moreover, the bromelain samples organoleptically were obtained slightly higher scores than cichorium treatments. From the economic point view, the experimental Domiaty cheese should be sold at one month than fresh cheese treatments. **Conclusion:** According to the physical, biochemical and organoleptic properties, bromelain and cichorium extracts (0.1% and 0.2%) has been enhanced of Domiaty cheese properties. Economically, cichorium and bromelain Domiaty cheese should be sold at one month than fresh Domiaty cheese.

Keywords: Bromelain, Cichorium, Domiaty cheese, Moisture, Ripening indices

INTRODUCTION

Domiat cheese is the most popular soft white pickled cheese in Egypt and makes up about 75% of the cheese produced and consumed in approximately fifty-two countries. It differs especially from other pickled cheese varieties, such as Feta, Brinza, or Telema cheese, as the milk is salted before renneting step. The proportion of 5–14% salt depends on the season and temperature of cheese ripening. Domiat cheese can be from cow's or buffalo's milk or the mixture from the two types. The salted milk can be coagulated fresh or after pasteurization step without adding any starter. Also, Domiat cheese can be consumed either fresh or mostly after pickling step in salted whey or brine solution from 2 till 4 months¹.

The cheese ripening involves a complex series of biochemical changes which leads to taste, flavor and texture characteristics of cheese variety. The most of biochemical changes has been focused on the proteolysis that occurs by residual coagulant, indigenous milk enzymes, starter, non-starter microflora and enzymes from secondary flora². Moreover, the extracts of papain, bromelain and ficin have a desirable proteolytic for cheese during ripening period³.

As well known the cheese ripening considered a slow and expensive process. Therefore, the economic advantage from the acceleration of cheese ripening aims to more intense flavor in the shortest periods. Many studies were succeeded to accelerate of cheese ripening using microbial proteinases, while the microbial proteinases are expensive beside the bitterness flavor was observed⁴⁻⁶.

Papain enzyme is a cysteine protease and have many applications in food industry, pharmaceutical and medicine. Also, it has been isolated from the latex of papaya fruit⁷. According to Rowan *et al.*⁸, the bromelain is a group of proteolytic enzymes, found in tissues of *Bromeliaceae*. Pineapple (*Ananas comosus* L.) is the best source for bromelain enzyme. Bromelain constitutes an unusually complex mixture of different thiol-endopeptidases. Chicory (*Cichorium intybus* L.) is a herbaceous plant, related to *Asteraceae*. Chicory plant grows in Egypt as a secondary crop with the clover crop through winter season. Chicory leaves are widely consumed in the Egyptian village within the breakfast meal. Previously, the chicory plant was proved a safe herb by US Food and Drug Administration Poisonous Plant Database, Cornell University Poisonous Plants Informational Database⁹. All parts of this plant are pharmacologically useful due to presence of several compounds such as alkaloids, flavonoids, inulin, caffeic acid derivatives, sesquiterpene lactones, steroids, terpenoids, oils, volatile compounds, coumarins and vitamins¹⁰.

Domiat Cheese Properties Using Cichorium and Bromelain Extracts

Previously, *Cichorium intybus* was used as a source of proteolytic enzymes to accelerate of Domiat cheese ripening

¹¹. The purpose of present study was focused on use bromelain and cichorium extracts for improvement of Domiat cheese properties.

MATERIALS AND METHODS

Study area: The present study was carried out at Dairy Department, Faculty of Agriculture, Suez Canal University, Ismailia 41522, Egypt from April - September, 2021.

Materials: Fresh buffalo's milk (16.25% total solids, 6.5% fat, 3.85% protein, pH 6.72 and 0.17% acidity) was obtained from the pilot plant of Dairy Department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. Chicory (*Cichorium intybus* L.), pineapple (*Ananas comosus* L.) and commercial fine grade salt were purchased from local market, Ismailia, Egypt. Calcium chloride, cadmium chloride and ninhydrin were obtained from Al Gomhoria Co., Cairo, Egypt. Microbial rennet powder (produced by fermentation of *Aspergillus niger* var. *awamori*) were obtained from Hansen's Laboratories, Denmark. All chemicals used in the present search were of analytical grade.

Methods:

Extraction of crude enzymes: The plant extraction was done according to Hale *et al.*¹² with some modifications. Bromelain and cichorium were obtained from pineapple and chicory respectively. Wastes of pineapple and chicory leaves were removed by knife and discarded. The obtained parts of pineapple and chicory were cut into small pieces, cleaned by tap water, followed by milling with a mortar and pestle and then centrifuging (3000 rpm / 30 min, at 4°C) using (HERMLE Labor-tech GmbH). The obtained supernatants were used as crude enzymes in Domiat cheese making.

Domiat cheese making: Experimental Domiat cheese was conducted according to Scott,¹³ with some modifications. Fresh buffalo's milk was partially skimmed (13.65% TS, 4% fat, 3.92% protein, pH 6.68 and 0.18% acidity). The cheese milk was divided into five treatments. The first treatment represented as control sample. Other treatments were carried out as the follows: Cheese milks were heated to 70°C for 1 min then cooled to 38°C, followed by adding 6% sodium chloride and 0.02% calcium chloride. The second and third treatments were done by adding 0.1 and 0.2% crude enzymes extracts of chicory and pineapple to milk, followed by adding 7 g microbial rennet powder / 100 kg cheese milk. Whey of cheese treatments was collected, pasteurized and then Domiat cheese were pickled in the pasteurized whey.

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The fourth and fifth treatments were carried out such as the foregoing treatments without adding crude enzyme to cheese milk, while its added to the pickled Domiati cheese at levels 0.1 and 0.2%. All treatments were stored up to 28 days in the

refrigerator at 5°C. The required examinations were carried out every week.

Experimental examinations

Analysis of milk: Buffalo's milk was analyzed for total solids, acidity and fat content according to Association of Official Analytical Chemists (AOAC),¹⁴. The pH values of samples were determined using a digital pH meter (Jenway electrode no. 3505, Dunmow, England). The protein content was estimated by the semi-micro-kjeldahl method¹⁴.

Analysis of Domiati cheese: Moisture content was determined according to IDF,¹⁵. Total nitrogen (TN), fat, salt, acidity and pH value of samples were determined according to AOAC,¹⁴.

Assessment of cheese proteolysis: Water soluble nitrogen (WSN) was determined according to micro-kjeldahl method¹⁴. Cadmium method for determination of free amino acids (FAA) in cheese sample according to Folkertsma and Fox,¹⁶. Cd-ninhydrin reagent: 0.8 ninhydrin were dissolved in mixture of 80 ml 99.5% ethanol and 10ml acetic acid, followed by adding of 1g diluted to 1 ml distilled water. A 2 ml Cd-ninhydrin reagents was added. The mixture was heated at 84°C for 5 min, cooled and the absorbance at 507 nm was measured using Varian Cary (UV/Visible double beam) spectrophotometer (Varian Australia Pty. Ltd). A blank (reagent without WSN) was prepared.

Organoleptic properties: The sensory evaluation of cheese samples were examined as described by Nelson and Trout,¹⁷. The parameters of taste & flavor (0 – 50 points), body & texture (0 – 35 points) and appearance & color (0 – 15 points) were done by staff members of Dairy department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.

Firmness of treatments: Domiati cheese samples were sliced into 1 cm and thickness with 6x6 cm. (length and wide). The Brabender Structograph model 8603 with spindle No. 449651 (cone probe 15°) was used to determine the firmness. The heights of resultant curve express as the firmness, while the curve base express as the elasticity of the Domiati cheese. These measurements were replicated three times for each cheese sample.

Domiat Cheese Properties Using Cichorium and Bromelain Extracts
Cost of cheese production: As shown in Table 1, the production costs of all cheese treatments were calculated according to prices of materials used in Domiati cheese manufacture in the Egyptian market.

Table 1. Production costs of materials used in Domiati cheese manufacture

Item	Cost
Partial skim milk (4% fat)	(L.E. 8/1 Kg)
Table salt	(L.E. 2/1 Kg)
CaCl ₂	(L.E. 60 /1 Kg)
Microbial rennet	(L.E. 700 /500 g)
Crude cichorium extract	(L.E. 0.05 /1 ml)
Crude pineapple extract	(L.E. 50 /100 ml)
White muslin fabric	(L.E. 15 /1 Meter)
Tap water	(L.E. 4.55/1 cubic meter)
Electricity	(L.E. 1.40/1 kilowatt)
Plastic container	(L.E. 13/ each one)
Polyethylene sheets	(L.E. 1.5/ each container)
Cost of using equipment (Rental cost) (L.E.)	70
Labor charges	(L.E. 150/8 hrs)

Statistical analysis: The obtained results were analyzed statistically in one-way analysis of variance using computer program software SPSS 16 (SPSS Inc., Chicago, USA). Duncan analysis was used at p<0.05 to determine the changes between means.

RESULTS AND DISCUSSION

Chemical composition of Domiati cheese

Moisture content: Moisture content of cichorium and bromelain Domiati cheese are presented in Table 2. Obviously, the present results revealed that no significant (p>0.05) differences in the moisture content between control sample and other treatments, while the significant (p<0.05) decreases were noticed during the ripening period from 1–28 days, this can be attributed to the contraction of curd, because of the developing acidity as the proceeding of pickling period, which in turn led to whey off¹⁸. Also, our studies are in agreement with that observed by Abou-Zeid and El-Sisi,¹¹.

Fat content and fat /dry matter: The fat content are greatly affects the palatability of cheese, as its also partly responsible for the smoothness and richness of body and texture of end products¹⁹. As shown in Table 3, the differences between fat content and fat/dry matter (F/DM) of control samples and other cheese samples (T2–T5) were significant (p<0.05). It is remarkable that the changes in fat content and F/DM were slightly concerning the increase of cichorium and bromelain extracts, stages of adding crude enzymes and the variation

between cichorium and bromelain treatments. Ismail *et al.*²⁰ reported that the decrease in solids not fat had been related to the protein degradation besides the partial loss in whey during cheese ripening, this could be caused slight increase in F/DM of Domiati cheese. Regarding the storage periods, both fat content and F/DM of

all treatments were significantly ($p < 0.05$) increased due to the progressive loss in moisture content during ripening

period. Our results are in line with that mentioned by Abou-Zeid and El-Sisi,¹¹.

Table 2. Effect of cichorium and bromelain extracts on moisture content of Domiati cheese

Days	Moisture content (%)▼				
	Cichorium treatments				
	T1*	T2	T3	T4	T5
1	59.46±0.92 ^{Aa}	59.37±0.45 ^{Aa}	59.62±0.62 ^{Aa}	59.31±0.47 ^{Aa}	59.82±0.70 ^{Aa}
7	58.40±0.67 ^{Aa}	58.07±0.77 ^{Ab}	58.98±0.28 ^{Aa}	58.06±0.88 ^{Aab}	58.65±0.62 ^{Ab}
14	56.91±0.55 ^{Ab}	57.78±0.90 ^{Ab}	57.56±0.96 ^{Ab}	56.92±0.50 ^{Abc}	57.23±0.52 ^{Ac}
21	55.62±0.83 ^{Abc}	55.47±0.35 ^{Ac}	56.02±0.82 ^{Ac}	55.64±0.73 ^{Ac}	55.94±0.42 ^{Ad}
28	54.45±0.75 ^{Ac}	54.55±0.58 ^{Ac}	54.65±0.58 ^{Ad}	54.77±0.94 ^{Ad}	54.79±0.84 ^{Ae}
Days	Bromelain treatments				
1	59.46±0.92 ^{Aa}	59.34±0.46 ^{Aa}	59.59±0.27 ^{Aa}	59.29±0.54 ^{Aa}	59.84±0.69 ^{Aa}
7	58.40±0.67 ^{Aa}	57.99±0.84 ^{Ab}	58.23±0.87 ^{Ab}	58.58±0.93 ^{Aab}	58.07±0.74 ^{Ab}
14	56.91±0.55 ^{Ab}	56.89±0.75 ^{Ab}	56.94±0.50 ^{Ac}	57.33±0.37 ^{Abc}	56.68±0.25 ^{Ac}
21	55.62±0.83 ^{Abc}	55.64±0.35 ^{Ac}	55.55±0.62 ^{AcD}	56.06±0.66 ^{AcD}	55.59±0.85 ^{Ac}
28	54.45±0.75 ^{Ac}	54.38±0.57 ^{Ad}	54.36±0.77 ^{Ad}	54.26±0.81 ^{Ad}	54.21±0.45 ^{Ad}

Capital letters: average values are significant ($p < 0.05$) with the different letters for the row; Small letters: average values are significant ($p < 0.05$) with the different letters for the column; T1*: control; T2: adding 0.1% of crude cichorium or bromelain extracts to the milk before renneting; T3: adding 0.2% of crude cichorium or bromelain extracts to milk before renneting; T4: adding 0.1% of crude cichorium or bromelain extracts to pickled Domiati cheese; T5: adding 0.2% of crude cichorium or bromelain extracts to pickled Domiati cheese; ▼: average values

Table 3. Impact of cichorium and bromelain extracts on fat content and Fat/DM ratio of Domiati cheese

Days	Fat content (%)▼				
	Cichorium treatments				
	T1*	T2	T3	T4	T5
1	16.50±0.11 ^{Ae}	16.40±0.16 ^{Ae}	16.30±0.10 ^{Abe}	16.30±0.08 ^{Abe}	16.10±0.11 ^{Be}
7	17.20±0.15 ^{Ad}	17.20±0.12 ^{Ad}	17.20±0.23 ^{Ad}	17.10±0.15 ^{Ad}	16.90±0.16 ^{Ad}
14	18.00±0.10 ^{Ac}	17.80±0.18 ^{ABc}	17.70±0.16 ^{Abc}	17.60±0.22 ^{Bc}	17.50±0.21 ^{Bc}
21	19.20±0.14 ^{Ab}	18.90±0.19 ^{ABb}	18.70±0.20 ^{Bb}	18.60±0.21 ^{Bb}	18.20±0.11 ^{Cb}
28	20.00±0.17 ^{Aa}	19.40±0.10 ^{Ba}	19.20±0.11 ^{Bca}	19.00±0.10 ^{CDa}	18.90±0.10 ^{Da}
Days	Bromelain treatments				
1	16.50±0.11 ^{Ae}	16.40±0.21 ^{Abe}	16.30±0.14 ^{ABCe}	16.20±0.10 ^{BCE}	16.10±0.12 ^{Ce}
7	17.20±0.15 ^{Ad}	17.20±0.14 ^{Ad}	17.10±0.10 ^{ABd}	17.00±0.21 ^{ABd}	16.80±0.21 ^{Bd}
14	18.00±0.10 ^{Ac}	17.80±0.18 ^{ABc}	17.60±0.17 ^{BCC}	17.60±0.13 ^{BCC}	17.50±0.13 ^{Cc}
21	19.20±0.14 ^{Ab}	18.90±0.22 ^{ABb}	18.60±0.20 ^{Bcb}	18.50±0.12 ^{Cb}	18.10±0.15 ^{Db}
28	20.00±0.17 ^{Aa}	19.30±0.21 ^{Ba}	19.10±0.16 ^{Bca}	19.00±0.10 ^{CDa}	18.80±0.20 ^{Da}
Days	Fat / DM ratio▼				
	Cichorium treatments				
1	40.70±0.18 ^{Ae}	40.36±0.16 ^{Abe}	40.37±0.23 ^{Abe}	40.07±0.25 ^{BCE}	39.81±0.20 ^{Ce}
7	41.69±0.15 ^{Ad}	41.35±0.15 ^{Bd}	41.12±0.13 ^{BCd}	41.02±0.17 ^{CDd}	40.77±0.17 ^{Dd}
14	42.05±0.25 ^{Ac}	41.95±0.17 ^{Bc}	41.78±0.14 ^{BCC}	41.31±0.33 ^{CDc}	41.09±0.22 ^{Dc}
21	43.04±0.10 ^{Ab}	42.74±0.19 ^{ABb}	42.41±0.19 ^{Bb}	41.99±0.24 ^{Cb}	41.31±0.24 ^{Db}
28	43.91±0.17 ^{Aa}	43.15±0.20 ^{Ba}	42.95±0.21 ^{Bca}	42.25±0.27 ^{CDa}	41.79±0.28 ^{Da}
Days	Bromelain treatments				
1	40.70±0.18 ^{Ae}	40.34±0.15 ^{Abe}	40.34±0.21 ^{Abe}	40.06±0.35 ^{BCE}	39.78±0.22 ^{Ce}
7	41.69±0.15 ^{Ad}	40.94±0.16 ^{Bd}	41.11±0.23 ^{Bd}	41.00±0.19 ^{Bd}	40.31±0.19 ^{Cd}
14	42.05±0.25 ^{Ac}	41.81±0.20 ^{ABc}	41.51±0.17 ^{BCC}	41.25±0.21 ^{Cc}	40.75±0.18 ^{Dc}
21	43.04±0.10 ^{Ab}	42.45±0.18 ^{Bb}	42.34±0.26 ^{Bcb}	41.74±0.21 ^{Cb}	41.22±0.16 ^{Db}
28	43.91±0.17 ^{Aa}	42.69±0.20 ^{Ba}	42.52±0.25 ^{Bca}	42.15±0.24 ^{Ca}	41.59±0.26 ^{Da}

See footnote Table 2

Total nitrogen of Domati cheese: As shown in Table 4, it is clear that the results of total nitrogen (TN) and TN/DM ratio showed significant ($p < 0.05$) differences between samples of T2–T5 and control samples. Also, from T2 till T5, the gradual significant ($p < 0.05$) increases in the TN values and TN/DM ratios were observed. Moreover, the effects of increase plant extracts and adding of extracts into the brine whey were caused significant ($p < 0.05$) increases in the TN. After 28 days at the refrigerator temperature, the TN of all cheese treatments were increased significantly ($p < 0.05$) according to the statistical analysis due to the protein degradation by plant extracts besides other ripening factors and formation of nitrogenous compounds²¹. Results of the present study in harmony with that mentioned by Khalifa and Wahdan,²² when they used cranberry (*Vaccinium macrocarpon*) fruit extract to improve white soft cheese characteristics. Both the TN values and TN/DM ratios of bromelain Domati cheese were slightly higher than cichorium treatments. Our results are in contrast with the foregoing studies^{23,24}, as their TN/DM ratios of Edam cheese has been increased for most

the storage period, and then decreased before the last sensory evaluation.

Salt and salt/moisture contents of Domati cheese: Table 5 showed that the salt and salt-in-moisture contents of Domati cheese samples were ranged in narrow values, however the differences in the previous parameters for each control samples and treatments of the two plant extracts were not significant ($p > 0.05$). As well as the effects of crude plant enzymes on the obtained results were fluctuated, in addition the relation between the salt and salt/moisture contents from the one hand and moisture content from the other hand was reversible. Extract of moringa leaves had been used in production of functional white soft cheese as a result of Abd El-Wahed and Osman,²⁵. It is remarkable that the salt content beside salt/moisture ratio for all cheese samples have been increased significantly ($p < 0.05$) as the storage period proceeding, this can be justified by the loss in moisture content of cheese samples which in turn lead to a more salt concentration²⁶.

Table 4. Effect of cichorium and bromelain extracts on TN and TN/DM ratio

Days	TN (%)▼				
	Cichorium treatments				
	T1*	T2	T3	T4	T5
1	1.53±0.04 ^{Ae}	1.53±0.06 ^{Ae}	1.55±0.03 ^{Ae}	1.57±0.06 ^{Ae}	1.59±0.03 ^{Ae}
7	1.16±0.06 ^{Ed}	1.81±0.04 ^{Dd}	1.88±0.06 ^{Cd}	1.99±0.04 ^{Bd}	2.09±0.02 ^{Ad}
14	1.72±0.02 ^{Ec}	2.02±0.02 ^{Dc}	2.10±0.05 ^{Cc}	2.18±0.02 ^{Bc}	2.28±0.05 ^{Ac}
21	1.87±0.03 ^{Eb}	2.11±0.03 ^{Db}	2.22±0.02 ^{Cb}	2.31±0.05 ^{Bb}	2.49±0.06 ^{Ab}
28	2.00±0.05 ^{Ea}	2.23±0.05 ^{Da}	2.32±0.04 ^{Ca}	2.44±0.03 ^{Ba}	2.65±0.06 ^{Aa}
Days	Bromelain treatments				
1	1.53±0.04 ^{Ae}	1.55±0.04 ^{Ae}	1.56±0.06 ^{Ae}	1.57±0.03 ^{Ae}	1.61±0.06 ^{Ae}
7	1.60±0.06 ^{Ed}	1.85±0.02 ^{Dd}	1.94±0.03 ^{Cd}	2.04±0.02 ^{Bd}	2.14±0.04 ^{Ad}
14	1.72±0.02 ^{Ec}	2.05±0.03 ^{Dc}	2.14±0.05 ^{Cc}	2.22±0.05 ^{Bc}	2.33±0.02 ^{Ac}
21	1.87±0.03 ^{Eb}	2.17±0.06 ^{Db}	2.28±0.02 ^{Cb}	2.36±0.04 ^{Bb}	2.55±0.05 ^{Ab}
28	2.00±0.05 ^{Ea}	2.27±0.03 ^{Da}	2.37±0.04 ^{Ca}	2.48±0.06 ^{Ba}	2.69±0.03 ^{Aa}
Days	TN/DM ratio▼				
	Cichorium treatments				
1	3.77±0.18 ^{Bb}	3.81±0.19 ^{Be}	3.84±0.13 ^{Abe}	3.86±0.17 ^{Abe}	3.96±0.14 ^{Ae}
7	3.85±0.15 ^{Db}	4.22±0.17 ^{Cd}	4.42±0.18 ^{Bd}	4.63±0.19 ^{Bd}	5.05±0.12 ^{dA}
14	3.99±0.20 ^{Db}	4.51±0.15 ^{Cc}	4.83±0.23 ^{Bc}	4.88±0.10 ^{Bc}	5.33±0.18 ^{Ac}
21	4.21±0.21 ^{Da}	4.74±0.11 ^{Cb}	5.05±0.14 ^{Bb}	5.09±0.20 ^{Bb}	5.65±0.17 ^{Ab}
28	4.27±0.16 ^{Da}	4.94±0.17 ^{Ca}	5.23±0.15 ^{Ba}	5.33±0.16 ^{Ba}	5.86±0.20 ^{Aa}
Days	Bromelain treatments				
1	3.77±0.18 ^{Bb}	3.79±0.14 ^{Be}	3.84±0.20 ^{Abe}	3.83±0.12 ^{Abe}	4.98±0.22 ^{Ae}
7	3.85±0.15 ^{Db}	4.38±0.13 ^{Cd}	4.60±0.10 ^{Bd}	4.70±0.15 ^{Bd}	5.08±0.18 ^{Ad}
14	3.99±0.20 ^{Eb}	4.58±0.20 ^{Dc}	4.89±0.22 ^{Cc}	5.09±0.22 ^{Bc}	5.36±0.20 ^{Ac}
21	4.21±0.21 ^{Ea}	4.76±0.18 ^{Db}	5.11±0.14 ^{Cb}	5.30±0.18 ^{Bb}	5.69±0.21 ^{Ab}
28	4.27±0.16 ^{Ea}	4.98±0.15 ^{Da}	5.31±0.16 ^{Ca}	5.53±0.25 ^{Ba}	5.95±0.13 ^{Aa}

See footnote Table 2

Table 5. Effect of crude plant extracts on salt content and salt / moisture content ratio of Domiaty cheese

Days	Salt content (%)▼				
	Cichorium treatments				
	T1*	T2	T3	T4	T5
1	4.02±0.11 ^{Ae}	4.07±0.13 ^{Ae}	4.03±0.10 ^{Ae}	4.08±0.10 ^{Ae}	3.99±0.11 ^{Ae}
7	4.16±0.08 ^{Ad}	4.22±0.11 ^{Ad}	4.14±0.11 ^{Ad}	4.20±0.13 ^{Ad}	4.15±0.09 ^{Ad}
14	4.30±0.11 ^{Ac}	4.33±0.12 ^{Ac}	4.28±0.10 ^{Ac}	4.35±0.10 ^{Ac}	4.27±0.13 ^{Ac}
21	4.47±0.13 ^{Ab}	4.45±0.12 ^{Ab}	4.46±0.13 ^{Ab}	4.48±0.12 ^{Ab}	4.44±0.07 ^{Ab}
28	4.65±0.10 ^{Aa}	4.68±0.10 ^{Aa}	4.70±0.12 ^{Aa}	4.69±0.09 ^{Aa}	4.66±0.12 ^{Aa}
Days	Bromelain treatments				
1	4.02±0.11 ^{Ae}	4.06±0.13 ^{Ae}	3.99±0.11 ^{Ae}	4.05±0.09 ^{Ae}	3.97±0.10 ^{Ae}
7	4.16±0.08 ^{Ad}	4.17±0.12 ^{Ad}	4.19±0.12 ^{Ad}	4.21±0.11 ^{Ad}	4.18±0.09 ^{Ad}
14	4.30±0.11 ^{Ac}	4.34±0.09 ^{Ac}	4.29±0.13 ^{Ac}	4.36±0.13 ^{Ac}	4.28±0.12 ^{Ac}
21	4.47±0.13 ^{Ab}	4.44±0.10 ^{Ab}	4.48±0.09 ^{Ab}	4.45±0.10 ^{Ab}	4.43±0.08 ^{Ab}
28	4.65±0.10 ^{Aa}	4.67±0.12 ^{Aa}	4.69±0.12 ^{Aa}	4.66±0.12 ^{Aa}	4.64±0.12 ^{Aa}
Days	Salt / moisture content ratio▼				
Cichorium treatments					
1	6.76±0.12 ^{Ae}	6.86±0.10 ^{Ae}	6.76±0.13 ^{Ae}	6.88±0.07 ^{Ae}	6.70±0.11 ^{Ae}
7	7.12±0.11 ^{Ad}	7.27±0.09 ^{Ad}	7.14±0.08 ^{Ad}	7.23±0.10 ^{Ad}	7.15±0.14 ^{Ad}
14	7.56±0.14 ^{Ac}	7.49±0.11 ^{Ac}	7.44±0.10 ^{Ac}	7.64±0.11 ^{Ac}	7.45±0.09 ^{Ac}
21	8.04±0.10 ^{Ab}	8.02±0.12 ^{Ab}	7.96±0.11 ^{Ab}	8.05±0.12 ^{Ab}	7.94±0.13 ^{Ab}
28	8.54±0.15 ^{Aa}	8.58±0.14 ^{Aa}	8.60±0.09 ^{Aa}	8.59±0.13 ^{Aa}	8.51±0.10 ^{Aa}
Bromelain treatments					
1	6.76±0.12 ^{Ae}	6.84±0.09 ^{Ae}	6.70±0.08 ^{Ae}	6.83±0.11 ^{Ae}	6.69±0.12 ^{Ae}
7	7.12±0.11 ^{Ad}	7.19±0.11 ^{Ad}	7.17±0.010 ^{Ad}	7.20±0.12 ^{Ad}	7.18±0.15 ^{Ad}
14	7.56±0.14 ^{Ac}	7.63±0.12 ^{Ac}	7.53±0.11 ^{Ac}	7.60±0.09 ^{Ac}	7.55±0.12 ^{Ac}
21	8.04±0.10 ^{Ab}	7.93±0.13 ^{Ab}	8.06±0.12 ^{Ab}	7.97±0.13 ^{Ab}	7.94±0.08 ^{Ab}
28	8.54±0.15 ^{Aa}	8.59±0.10 ^{Aa}	8.63±0.13 ^{Aa}	8.56±0.10 ^{Aa}	8.50±0.12 ^{Aa}

See footnote Table 2

Physicochemical properties of treatments

The pH values: Table 6 shows the influences of crude plant enzymes on pH values of T2 till T5 as compared with control samples were significant ($p < 0.05$). In general, the pH values of T2 compared to T4 and T3 compared to T5 were statistically ($p < 0.05$) higher. Moreover, the pH values of cichorium and bromelain Domiaty cheese were ordered as a follow: T2 > T3 > T4 > T5. In addition, the pH values of

bromelain treatments were slightly decreased than cichorium treatments. The significant ($p < 0.05$) decreases in pH values of all cheese samples during the storage times were attributed by the fermentation of residual lactose and other compounds^{27,28}. The present results agree with that mentioned by El-Aziz *et al.*²⁹, they produced soft cheese fortified with ginger extract, as well the same finding was observed using the brine solution beside ginger extracts on cheese properties.

Table 6. Effect of cichorium and bromelain extracts on pH values of treatments

Days	pH values▼				
	Cichorium treatments				
	T1*	T2	T3	T4	T5
1	6.51±0.03 ^{Aa}	6.45±0.06 ^{ABa}	6.42±0.04 ^{Ba}	6.42±0.05 ^{Ba}	6.40±0.03 ^{Ba}
7	6.23±0.04 ^{Ab}	6.22±0.04 ^{ABb}	6.19±0.05 ^{ABb}	6.15±0.03 ^{BCb}	6.12±0.04 ^{Cb}
14	5.94±0.06 ^{Ac}	5.83±0.03 ^{Bc}	5.78±0.06 ^{BCc}	5.70±0.06 ^{CDc}	5.61±0.06 ^{Dc}
21	5.72±0.05 ^{Ad}	5.55±0.07 ^{Bd}	5.50±0.07 ^{BCd}	5.44±0.04 ^{Cd}	5.34±0.03 ^{Dd}
28	5.40±0.07 ^{Ae}	5.33±0.05 ^{Abe}	5.27±0.04 ^{Be}	5.18±0.07 ^{Ce}	4.93±0.05 ^{De}
Days	Bromelain treatments				
1	6.51±0.03 ^{Aa}	6.42±0.04 ^{Ba}	6.40±0.04 ^{Ba}	6.38±0.07 ^{Ba}	6.35±0.03 ^{Ba}
7	6.23±0.04 ^{Ab}	6.20±0.06 ^{ABb}	6.15±0.07 ^{ABb}	6.11±0.05 ^{BCb}	6.08±0.06 ^{Cb}
14	5.94±0.06 ^{Ac}	5.80±0.03 ^{Bc}	5.75±0.05 ^{Bc}	5.66±0.03 ^{Cc}	5.50±0.04 ^{Dc}
21	5.72±0.05 ^{Ad}	5.50±0.07 ^{Bd}	5.40±0.07 ^{BCd}	5.30±0.06 ^{Cd}	5.20±0.07 ^{Dd}
28	5.40±0.07 ^{Ae}	5.24±0.05 ^{Be}	5.18±0.06 ^{BCe}	5.10±0.04 ^{Ce}	4.81±0.05 ^{De}

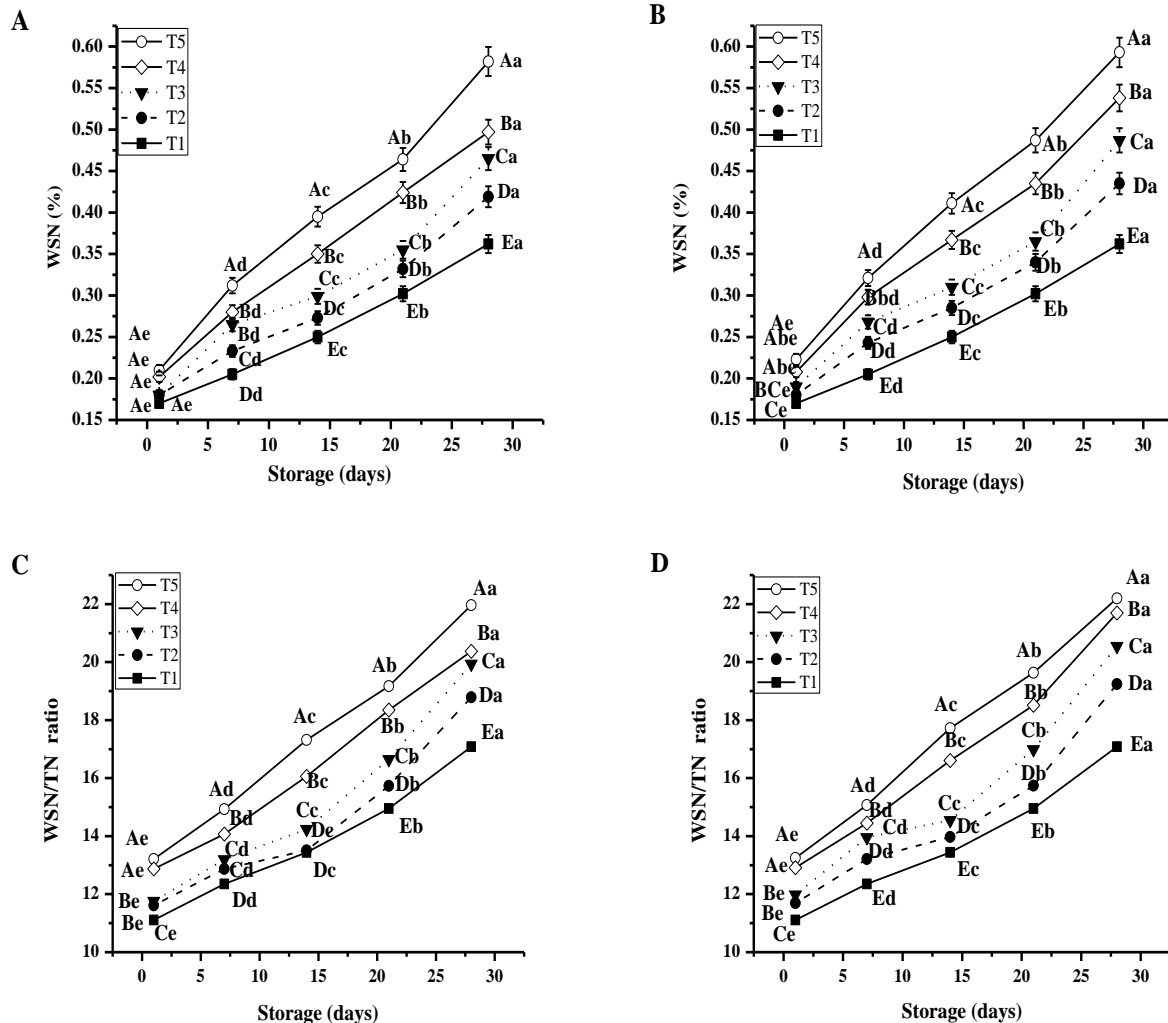
See footnote Table 2

Ripening indices

Water soluble nitrogen content and water soluble nitrogen in total nitrogen ratio: Fig. 1 (A, B, C and D) represents values of water soluble nitrogen (WSN) and water soluble nitrogen in total nitrogen (WSN/TN) for Domiate cheese. In respect of the WSN values, samples of T2 till T5 compared to control cheese were exhibited substantial ($p < 0.05$) increases, furthermore adding 0.1 and 0.2% chicory and pineapple extracts to the pickling cheese has been resulted an increase in the WSN values as compared to the same extracts to cheese milk. Remarkably, the bromelain Domiate cheese acquired a slight increase in the WSN than cichorium Domiate cheese. As the storage periods from 1 up to 28 days, the WSN percentages of each cichorium and bromelain Domiate cheese have been increased significantly

activity by the two extracts as an exogenous enzymes besides other factors such as rennet, plasmin and non-starter lactic acid bacteria³⁰.

Concerning the WSN/TN ratio, the significant ($p < 0.05$) increases between control samples and other cheese samples were observed, moreover the ripening index of T5 > T4 > T3 > T2 > T1 due to supporting of cheese samples with different levels of crude plant extracts. It could be noticed that the prolonging of storage up to 28 days caused the increase in WSN/TN ratio for all treatments, this may be explained by the partial degradation for protein content by the plant extracts and other factors. Results of the present work are in line with that noticed by Abou-Zeid and El-Sisi,¹¹. Also, the obtained observations by Abd El-Salam *et al.*³¹, when applies Artichoke (*Cynara cardunculus* L.) flowers as a coagulant for white soft cheese are in agreement with our finding.

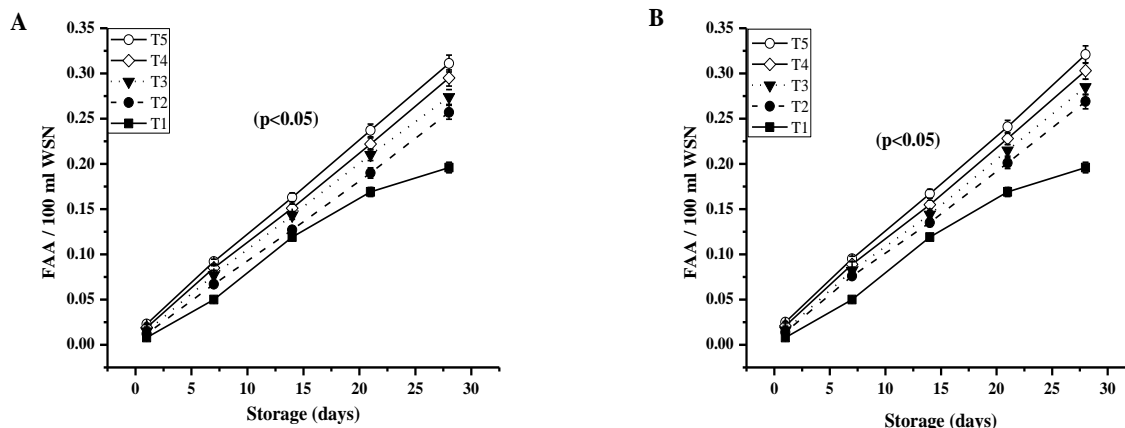


Capital letters: average values are significant ($p < 0.05$) with the different letters for different treatments; Small letters: average values are significant ($p < 0.05$) with the different letters for the same treatments

Fig. 1. Effect of cichorium extract (A and C) and bromelain extract (B and D) on WSN percentages and WSN/TN ratio

Free amino acids: The free amino acids (FAA) content can be contributed to flavor compounds either directly or indirectly as precursors for volatile aroma compounds such as aldehydes, acids, alcohols, esters and sulfur compounds³². The changes in FAA content of cheese samples are shown in Fig. 2 (A and B). Addition of crude enzymes extracts was induced a significant ($p < 0.05$) variation in the FAA content of cichorium and bromelain treatments as compared to control samples. As well as the FAA values of the experimental treatments increased in cases of the increase of plant extracts and for the pickling cheese. Noticeable, the FAA values of $T5 > T4 > T3 > T2 > T1$ along the storage period from 1 till 28 days, however the

rates of FAA values between samples of T2, T3, T4 and T5 along the storage times were close together. The ripening index of all cheese treatments significantly ($p < 0.05$) increased during the storage days due to the effect of cichorium and bromelain extracts besides the rennet, milk enzymes and other factors on proteolysis of cheese protein³⁰. Bromelain Domiati cheese compared to cichorium Domiati cheese were acquired slight increases in the FAA values. Our results are in harmony with that mentioned by Abou-Zeid and El-Sisi,¹¹ who used cichorium extract with different concentrations to accelerate Domiati cheese ripening, moreover the same results were obtained by Abd-El-Hady *et al.*²¹, they used the pancreatic extract to accelerate Domiati cheese ripening.



See footnote Fig. 1

Fig. 2. Effect of cichorium enzyme extract (A) and bromelain enzyme extract (B) on FAA values of Domiati cheese

Firmness of Domiati cheese: As known the maximum firmness represented as the lowest penetrometer reading (mm), whereas the minimum firmness represented as the highest penetrometer reading (mm). As shown in Table 7, no significant ($p > 0.05$) influences on the firmness of T2–T5 from one hand, and control from other hand were observed. On the other hand, the firmness values of cichorium and bromelain cheese treatments had been decreased significantly ($p < 0.05$) at the end of storage period owing of the decline in moisture content which in turn caused

an increase in dry matter³³. According to Creamer and Olson,³⁴ when the proteolysis occurs, more “new” ionic peptides are created; and as each “new” group is created, competition for available water increases; less water is available to solvate the protein chains and the resulting cheese is harder and less deformable. Results of the present work was in harmony with that reported by El-Aidie *et al.*³⁵, who found the firmness of UF processed cheese decreased at along of storage periods.

Table 7. Impact of crude cichorium and bromelain extracts on firmness of Domiati cheese

Days	Rheological evaluation ▼ [Firmness expressed as the height of curve in millimeter (mm)]				
	Cichorium treatments				
	T1*	T2	T3	T4	T5
1	2.642±0.075 ^{Aa}	2.634±0.088 ^{Aa}	2.627±0.091 ^{Aa}	2.650±0.077 ^{Aa}	2.619±0.078 ^{Aa}
28	2.245±0.070 ^{Ab}	2.234±0.061 ^{Ab}	2.229±0.086 ^{Ab}	2.238±0.055 ^{Ab}	2.221±0.080 ^{Ab}
Days	Bromelain treatments				
1	2.639±0.075 ^{Aa}	2.654±0.091 ^{Aa}	2.662±0.087 ^{Aa}	2.461±0.077 ^{Aa}	2.668±0.088 ^{Aa}

28	2.245±0.070 ^{Ab}	2.230±0.082 ^{Ab}	2.225±0.066 ^{Ab}	2.232±0.053 ^{Ab}	2.217±0.075 ^{Ab}
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See footnote Table 2

Sensory evaluation of Dommati cheese: The appearance & color, body & texture, taste & flavor and total score of all cheese samples are given in Table 8. In general, the changes in appearance & color scores of T2–T5 compared to control sample were not significant ($p>0.05$) from the panelists point view, in addition the obtained scores were increased gradually as the storage days proceeding. Furthermore, scores of each cichorium and bromelain samples were close together. Body & texture, taste & flavor and total score of cichorium or bromelain Dommati cheese were acquired the highest scores than other cheese controls. Moreover, addition of plant extracts whether during cheese making (T2 and T3) or for the brine whey (T4 and T5) significantly ($p<0.05$) enhanced the foregoing parameters. Samples of T4 compared to T2, and T5 compared to T3 were recorded a high sensory evolution because of occurrence the desirable proteolysis by crude plant extracts. Noteworthy, the experimental cheese which acquired less scores were acceptable by the panelists at 1 day owing of its

salty taste, in spite of the ripening flavor was formed yet³⁶. On the other hand, El Soda *et al.*³⁷, found that the presence of high salt levels in each cheese and brine whey can be regulated some enzymatic activities in cheese and delayed bitter flavor formation, moreover the bitter flavor could be masked by salty flavor. As the storage period proceeding, the experimental cheese have been recorded significantly ($p<0.05$) the higher scores due to role the plant extracts as the proteolytic factor besides other ripening factors. The present results are in the harmony with that obtained by Abd El-Aziz *et al.*³⁸ & Abd El-Wahed and Osman,²⁵ when they used the various plant sources to accelerate and improve Dommati cheese quality during ripening period. It could be noticed that the sensory evaluation of T5 > T4 > T3 > T2 > T1, in addition the bromelain Dommati cheese compared to cichorium Dommati cheese were ranked as the best treatments through the panelists scores. Also, we can say the changes in total scores of all Dommati cheese followed the same trend of taste & flavor beside body & texture.

Table 8. Impact of cichorium and bromelain extracts on the sensory evaluation of Dommati cheese

Days	Sensory evaluation ▼				
	Appearance & color (15)				
Cichorium	1 day	7 days	14 days	21 days	28 days
T1*	12.60±0.10 ^{Aa}	12.75±0.13 ^{Aa}	12.90±0.15 ^{Aa}	13.05±0.17 ^{Aa}	13.20±0.19 ^{Aa}
T2	12.75±0.11 ^{Aa}	12.90±0.12 ^{Aa}	13.05±0.14 ^{Aa}	13.20±0.18 ^{Aa}	13.35±0.20 ^{Aa}
T3	12.83±0.09 ^{Aa}	12.98±0.14 ^{Aa}	13.13±0.15 ^{Aa}	13.20±0.19 ^{Aa}	13.43±0.21 ^{Aa}
T4	12.90±0.12 ^{Aa}	13.05±0.15 ^{Aa}	13.13±0.16 ^{Aa}	13.28±0.17 ^{Aa}	13.65±0.23 ^{Aa}
T5	12.83±0.09 ^{Aa}	12.98±0.14 ^{Aa}	13.13±0.15 ^{Aa}	13.20±0.19 ^{Aa}	13.43±0.21 ^{Aa}
Bromelain	1 day	7 days	14 days	21 days	28 days
T1*	12.60±0.10 ^{Aa}	12.75±0.13 ^{Aa}	12.90±0.15 ^{Aa}	13.05±0.17 ^{Aa}	13.20±0.19 ^{Aa}
T2	12.75±0.12 ^{Aa}	12.93±0.13 ^{Aa}	13.11±0.16 ^{Aa}	13.23±0.19 ^{Aa}	13.43±0.21 ^{Aa}
T3	12.90±0.13 ^{Aa}	13.05±0.15 ^{Aa}	13.17±0.17 ^{Aa}	13.25±0.18 ^{Aa}	13.50±0.22 ^{Aa}
T4	12.90±0.10 ^{Aa}	13.05±0.14 ^{Aa}	13.20±0.15 ^{Aa}	13.32±0.17 ^{Aa}	13.73±0.24 ^{Aa}
T5	13.05±0.13 ^{Aa}	13.16±0.17 ^{Aa}	13.20±0.18 ^{Aa}	13.35±0.20 ^{Aa}	13.73±0.25 ^{Aa}
	Body & texture (35)				
Cichorium	1 day	7 days	14 days	21 days	28 days
T1*	21.09±0.10 ^{Ce}	22.87±0.20 ^{Cd}	24.61±0.31 ^{Dc}	25.59±0.42 ^{Db}	27.27±0.52 ^{Da}
T2	21.36±0.12 ^{Ce}	23.71±0.22 ^{BCd}	27.34±0.32 ^{Cc}	29.14±0.40 ^{Cb}	30.73±0.50 ^{Ca}
T3	22.75±0.14 ^{Be}	24.61±0.23 ^{Bd}	28.12±0.30 ^{Bc}	30.19±0.41 ^{BCb}	31.75±0.52 ^{BCa}
T4	23.63±0.16 ^{Abe}	25.50±0.21 ^{ABd}	29.02±0.32 ^{ABc}	30.81±0.43 ^{ABb}	32.47±0.51 ^{Ba}
T5	24.63±0.17 ^{Ae}	26.47±0.24 ^{Ad}	29.91±0.34 ^{Ac}	31.65±0.44 ^{Ab}	33.73±0.53 ^{Aa}
Bromelain	1 day	7 days	14 days	21 days	28 days
T1*	21.09±0.10 ^{Ce}	22.87±0.20 ^{Dd}	24.61±0.31 ^{Cc}	25.59±0.42 ^{Db}	27.27±0.52 ^{Da}
T2	21.98±0.11 ^{Ce}	24.50±0.24 ^{Cd}	28.09±0.34 ^{Cc}	29.93±0.43 ^{Cb}	31.50±0.51 ^{Ca}
T3	23.71±0.14 ^{Be}	25.49±0.25 ^{Bd}	28.92±0.35 ^{BCc}	30.80±0.42 ^{BCb}	32.48±0.53 ^{BCa}
T4	24.54±0.17 ^{Abe}	26.36±0.24 ^{ABd}	29.87±0.33 ^{ABc}	31.61±0.44 ^{ABb}	32.73±0.54 ^{Ba}
T5	25.50±0.18 ^{Ae}	27.23±0.27 ^{Ad}	30.80±0.35 ^{Ac}	32.46±0.45 ^{Ab}	34.13±0.55 ^{Aa}

Table 8. Continued

Taste & flavor (50)					
Cichorium	1 day	7 days	14 days	21 days	28 days
T1*	24.12±0.15 ^{Ce}	29.10±0.25 ^{Ed}	32.14±0.36 ^{Ec}	34.12±0.47 ^{Eb}	36.19±0.57 ^{Ea}
T2	24.15±0.14 ^{Ce}	31.12±0.24 ^{Dd}	34.25±0.35 ^{Dc}	36.19±0.45 ^{Db}	40.14±0.56 ^{Da}
T3	25.14±0.13 ^{Be}	32.31±0.22 ^{Cd}	36.17±0.33 ^{Cc}	38.25±0.43 ^{Cb}	43.27±0.52 ^{Ca}
T4	26.25±0.16 ^{Abe}	35.17±0.26 ^{Bd}	38.12±0.35 ^{Bc}	42.12±0.46 ^{Bb}	45.34±0.57 ^{Ba}
T5	27.13±0.18 ^{Ae}	37.15±0.27 ^{Ad}	41.10±0.36 ^{Ac}	43.55±0.45 ^{Ab}	47.12±0.55 ^{Aa}
Bromelain	1 day	7 days	14 days	21 days	28 days
T1*	24.12±0.15 ^{Ce}	29.10±0.25 ^{Ed}	32.14±0.36 ^{Ec}	34.12±0.47 ^{Eb}	36.19±0.57 ^{Ea}
T2	25.14±0.15 ^{BCe}	32.13±0.26 ^{Dd}	35.24±0.37 ^{Dc}	38.10±0.46 ^{Db}	42.13±0.55 ^{Da}
T3	26.24±0.12 ^{Be}	34.18±0.23 ^{Cd}	37.33±0.34 ^{Cc}	40.26±0.44 ^{Cb}	44.26±0.53 ^{Ca}
T4	27.31±0.17 ^{Abe}	37.16±0.21 ^{Bd}	40.12±0.36 ^{Bc}	43.41±0.45 ^{Bb}	46.53±0.58 ^{Ba}
T5	28.14±0.19 ^{Ae}	39.13±0.25 ^{Ad}	42.10±0.35 ^{Ac}	45.23±0.47 ^{Ab}	48.31±0.54 ^{Aa}
Cichorium	Total score (100)				
	1 day	7 days	14 days	21 days	28 days
T1*	56.62±0.35 ^{Ee}	63.74±0.58 ^{Ed}	68.87±0.82 ^{Ec}	72.06±1.06 ^{Eb}	76.15±1.28 ^{Ea}
T2	57.06±0.37 ^{De}	66.82±0.58 ^{Dd}	74.2±0.81 ^{Dc}	78.29±1.03 ^{Db}	84.16±1.26 ^{Da}
T3	59.69±0.36 ^{Ce}	69.08±0.59 ^{Cd}	77.06±0.78 ^{Cc}	81.55±1.03 ^{Cb}	88.50±1.25 ^{Ca}
T4	61.85±0.44 ^{Be}	73.01±0.62 ^{Bd}	80.04±0.83 ^{Bc}	86.18±1.06 ^{Bb}	91.55±1.31 ^{Ba}
T5	63.93±0.47 ^{Ae}	76.15±0.67 ^{Ad}	84.08±0.87 ^{Ac}	88.57±1.08 ^{Ab}	94.82±1.32 ^{Aa}
Bromelain	1 day	7 days	14 days	21 days	28 days
T1*	56.62±0.35 ^{Ee}	63.74±0.58 ^{Ed}	68.87±0.82 ^{Ec}	72.06±1.06 ^{Eb}	76.15±1.28 ^{Ea}
T2	58.76±0.38 ^{De}	68.75±0.63 ^{Dd}	76.08±0.87 ^{Dc}	81.13±1.08 ^{Db}	87.08±1.27 ^{Da}
T3	61.94±0.39 ^{Ce}	72.01±0.63 ^{Cd}	79.16±0.86 ^{Cc}	84.29±1.04 ^{Cb}	90.38±1.28 ^{Ca}
T4	63.96±0.44 ^{Be}	75.99±0.59 ^{Bd}	83.06±0.84 ^{Bc}	88.41±1.06 ^{Bb}	93.08±1.36 ^{Ba}
T5	65.98±0.50 ^{Ae}	79.02±0.69 ^{Ad}	86.10±0.88 ^{Ac}	91.23±1.12 ^{Ab}	96.46±1.34 ^{Aa}

Capital letter: mean values with different letters are significant ($p < 0.05$) for column; Small letter: mean values with different values are significant ($p < 0.05$) for row; ▼: mean values \pm SD.

Cost production and profits of Dommati cheese: The cost production and profits of cichorium and bromelain Dommati cheese are shown in Tables 9 and 10. The total costs of cheese treatments were calculated according to materials costs in Table 1. The differences between cheese controls and other cheese samples were slightly in cases of total cost of production, cost of one-kilogram fresh cheese and cost of one kilogram cheese after one month. Moreover, the cost of one kilogram cheese after one month was higher than the cost of one-kilogram fresh cheese due to adding of the interest (1 – 12% for 1 – 12 months) of the storage periods. Also, the commercial price for selling traditional Dommati cheese (fresh and one month storage was 53 and 62 Egyptian pounds) was determined according to the suppliers or middlemen who are responsible for dairy products in Ismailia governorate.

It is remarkable that the selling of traditional Dommati cheese at fresh and one month storage was higher than total costs of the experimental Dommati cheese at the same periods. From the economic point view, the experimental Dommati cheese should be sold at one month storage due to its the

profits were higher than fresh cheese. Previously the experimental attempt for economic evaluation was studied

by Hamad,³⁶ who obtained 100-kilogram white Feta cheese from six small factories. As known the profit of control cheese were near to other cheese samples, but the marketing of any product depends on the acceptability of consumers, which in turn comes from the sensory evaluation by panelists, therefore cichorium and bromelain Dommati cheese were best than controls, in addition the cheese samples of T5 > T4 > T3 > T2.

CONCLUSION

Briefly, the effect of bromelain and cichorium extracts (0.1% and 0.2%) on Dommati cheese properties showed that significant differences in moisture and protein contents, pH values, ripening indices (water soluble nitrogen, water soluble nitrogen in total nitrogen ratio and free amino acids) and the sensory evaluation, in addition both cichorium and bromelain cheese samples were acquired the best sensory evaluation whether their added into the cheese milk or the brine whey.

Bromelain cheese were slight better than cichorium treatments. Economically, cichorium and bromelain Domiati

Domati Cheese Properties Using Cichorium and Bromelain Extracts cheese should be sold at one month than fresh Domiati cheese.

Table 9. Cost production of cichorium and bromelain Domiati cheese

Cost production of cichorium Domiati cheese					
Total cost of production (L.E.)	1177.65	1178.15	1178.65	1178.15	1178.65
Cost of one kg. fresh cheese (L.E.)	1177.65/27.7 = 42.51	1178.15/27.7 = 42.53	1178.65/27.9 = 42.24	1178.15/27.8 = 42.37	1178.65/28 = 42.09
Cost of one kg. cheese approximately after one month [▼] (L.E.)	1177.65/24.7 = 47.67	1178.15/24.9 = 47.31	1178.65/25 = 47.146	1272.15/24.8 = 47.5	1272.65/25.1 = 46.95
Cost production of bromelain Domiati cheese					
Total cost of production (L.E.)	1177.65	1182.65	1187.65	1182.65	1182.65
Cost of one kg. fresh cheese (L.E.)	1177.65/27.7 = 42.51	1182.65/27.8 = 42.54	1187.65/27.8 = 42.72	1182.65/27.7 = 42.69	1187.65/28 = 42.41
Cost of one kg. cheese approximately after one month [▼] (L.E.)	1177.65/24.7 = 47.67	1182.65/24.7 = 47.88	1187.65/24.7 = 48.08	1182.65/24.9 = 47.49	1187.65/25 = 47.5

[▼]: [(total cost of production × the interest) + total cost of production]/yield; the interest = 1% per one month.

L.E: Egyptian pound; 1 American Dollar = 15.70 L.E. (the price differs according to daily exchange rate); 1 L.E. = 100 piaster; yield of T1, T2, T3, T4 and T5 at 1 month = 24.7, 24.9, 25, 24.8 and 25.1%

Table 10. Profit of cichorium and bromelain Domiati cheese

Treatments	Days	Profit of cichorium Domiati cheese			Profit of bromelain Domiati cheese		
		Price of selling (L.E.)	Cost per kg. cheese (L.E.)	Profit/kg. cheese (L.E.)	Price of selling (L.E.)	Cost per kg. cheese (L.E.)	Profit/kg. cheese (L.E.)
T1*	Fresh	53	42.51	10.49	53	42.51	10.49
	Month	58	47.67	10.33	58	47.67	10.33
T2	Fresh	53	42.53	10.47	53	42.54	10.46
	Month	62	47.31	14.69	62	47.88	14.12
T3	Fresh	53	42.24	10.76	53	42.72	10.28
	Month	62	47.50	14.50	62	48.08	13.92
T4	Fresh	53	42.37	10.63	53	42.69	10.31
	Month	62	47.50	14.50	62	47.49	14.51
T5	Fresh	53	42.09	10.91	53	42.41	10.59
	Month	62	46.95	15.05	62	47.50	14.50

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