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Evaluation of Changes of the Chemical , Rheological and Organoleptic Characteristics of Ras Cheese during Ripening

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ABSTRACT

Changes in the Principal Component Analysis (PCA) of local Ras cheese were examined. Chemical, rheological and organoleptic properties of the cheese were examined during the ripening period of 30, 60 and 90 days. The relationship between chemical and rheological data was estimated by the Canonicial Correlation Analysis. Ras cheese were collected from six different local cheese factories in fayoum governorate, at the age of 15 days. All experimental cheeses were transported and stored at 12±2°C and 88 % relative humidity for 90 days. The PCA describe three groups of cheese samples including 30, 60, and 90 days aged cheeses by testing the chemical and rheological changes during the ripening period. The PC_1 (30 days cheeses) characterized with higher moisture content, pH and cohesiveness values than PC3 samples (90 days cheese) which were of the highest water soluble nitrogen /total nitrogen, firmness, chewiness and gumminess values. The PC_2 distinguished the cheese being characterized by the highest fat and protein contents at 60 days. Strong correlations were established between the chemical and rheological CCA results. Continuous and gradual improvement in the sensory quality of all cheeses were observed during ripening period, attaining the highest score at the end of ripening period (90 days).

Keywords: Ras cheese ripening, chemical, rheological properties, principle component analysis, canonical correlation analysis.

INTRODUCTION

Ras cheese is one of the most important hard cheese in the Egypt, being marketed and commercialized as young Roumy cheese (of at least one month age), and old Roumy (3-6 month-age). Ras cheese is of open texture, slightly firm, salty and of sharp pungent flavor rather similar to "Kefalotyri cheese". It could be made of raw cow's milk or a mixture of cow's and buffalo's milk at ratio in the absence of starter. The fermentation was thus due to the contaminant flora of the raw milk and the environment under which the cheese is made (Hofi *et al.*, 1970Awad *et al.*, 2003).

Different aspects of Ras cheese were examined by Dabiza & El-Deib, 2007, Manal& Hanaa 2013,Ebide, 2016 and Abd-Elmontaleb, 2017). described the physicochemical, proteolysis, sensory and texture characteristics of Egyptian Ras cheese during the ripening period were evaluated byAwad (2006). Gunasekaran & Ak, 2003, Fox and McSweeney, 2004 and Awad (2006).

Statistical technique of Principle Component Analysis (PCA) was used in analysing the obtained results (Frau *et al.*, 1997 and Castell-Palou *et al.*, 2010 Principal). PCA allows summarizing the variable obtained data of the the samples classification. Furthermore, PCA has been used to differentiate between the different variables and to detect the causes of variability. Therefore, the objective of this work was to elucidate the quality of local Ras cheeses made in Fayoum governorate, during ripening period (30, 60 and 90 days) by PCA, and the relationships between the progressive developments in the chemical and rheological characteristics during ripening period by Canonical Correlation Analysis (CCA).

MATERIALS AND METHODS

Ras cheese of 15 day- age were collected from six different cheese factories in Fayoum governorate, Egypt, during winter (February 2015).

Ras cheese made in the dairy plants in Fayoum Governorate, Six experimental Ras cheeses were made (on the same day) from raw cow's milk according to Hofi *et al.* (1970). All cheeses were transferred to the Dairy Depart., Fac. Agric., Fayoum Univ and stored at 12±2°C and 88 % relative humidity for 90 days. For the chemical analysis of the cheese, the outer part of the cheese samples (2 mm under the crust) was removed and about 200 g sample was grated to 1 mm, as described by Guinee *et al.* (2000). The experimental cheese samples (200 g) were analyzed in triplicate after 30, 60 and 90 days by detecting the moisture, fat, salt, total nitrogen (TN) and water soluble nitrogen (WSN) according to A.O.A.C. (2010). pH values were measured by using a digital pH meter.

Cheese cubes (20 ×20×20 mm) were obtained from the middle of the cheese block and tempered to 12 ± 0.5ºC prior to analysis. Samples of texture measurements were carried out with the universal testing machine (Cometech, B type, Taiwan), provided with the software. Back extrusion cell with 35 mm diameter compression disc was used. Two cycles were applied, at a constant crosshead velocity of 1 mm/s, to 25% of sample depth, and then returned. From the resulting force–time curve, the values for texture attributes, i.e. firmness, gumminess, chewiness, cohesiveness and springiness of cheese samples were detected in triplicate from the TPA graphic according to Bourne(2002)

Cheese samples were sensory evaluated for flavor (50), body and texture (35) and appearance (15). during the ripening period (30, 60 and 90 days) by ten panelists of the staff members at dairy department, Faculty of Agriculture, Fayoum University, ac cording to the scoring sheet recommended by Hofi *et al.* (1970).

The obtained results were statistically analyzed by calculating the average and standard deviation for each parameter. PCA was used to the chemical and textural data, whereas the combined chemical and rheological data were further analyzed using (CCA) that describes the correlation between two sets of data (Karoui *et al.*, 2006).

RESULTS AND DISCUSSION

Changes in the chemical analysis of Ras cheese during the ripening period are presented in Table 1). It could be seen that the moisture content decreased in all cheeses samples during the ripening periods due to water evaporation from cheese surface (Awad 2006; Aminifar and Emam-Djomeh, 2014). Ras cheese taken from the six cheese factories at 30 days had an average moisture, protein, fat, salt contents of 34.51, 24.37, 34.78 and 4.32%, respectively. pH decreased up to 30 days, which confirm the metabolic activity of lactic acid bacteria. Fat content in the dry matter (F/DM) was within the range of Egyptian standards for Ras cheese. slight decrease, however, was observed in F/DM, which agrees with Ahmed *et al.*, (2015).

Table 1. Changes in some chemical composition of Ras cheese during the ripening period.

Parameters	Ripening period (days)	Mean ± SD	Minium	Maximum
pH	30	5.39 ± 0.1	5.30	5.50
	60	5.30 ± 0.1	5.20	5.40
	90	5.14 ± 0.1	5.00	5.30
Moisture (%)	30	34.51 ± 0.8	33.24	35.78
	60	32.19 ± 0.9	30.61	33.90
	90	30.95 ± 1.0	28.94	32.11
Fat (%)	30	34.78 ± 2.5	29.00	37.00
	60	35.67 ± 2.1	31.00	38.00
	90	36.39 ± 2.0	32.00	39.00
Total Protein (%)	30	24.37 ± 0.9	23.11	25.97
	60	25.50 ± 0.9	24.45	27.14
	90	26.45 ± 1.1	25.17	28.12
WSN/TN (%)	30	08.84 ± 0.6	07.94	09.67
	60	16.30 ± 0.9	14.78	17.54
	90	20.45 ± 1.1	18.67	22.28
Fat/DM (%)	30	53.13 ± 4.1	43.56	56.75
	60	52.63 ± 3.5	44.80	56.06
	90	52.73 ± 3.4	45.17	55.84
Salt (%)	30	04.32 ± 0.2	04.00	04.70
	60	04.48 ± 0.2	04.20	04.80
	90	04.56 ± 0.2	04.20	04.90

WSN: water soluble nitrogen TN: total nitrogen
DM: Dry matter SD: standard deviations

PCA was applied to the chemical data (18 objects and 7 variables) and the similarity map defined by principal components 1 and 2 described 89.8% of the total variance in the data. The similarity map and the factor loadings of the first two principal components (2PCs) are shown in Fig 1). Similar PCA map explains the age of cheese. Cheeses could be classified into 3 groups according to their age. All cheeses were of closely similar cluster in the each region of the PCs, and the cheeses varied pronouncedly. Results of PCA in Fig 1 a and b) show that the cheese samples of 30- day age were in the negative side PC1 axis, and were of higher moisture content and pH, than the other cheeses. Samples of 90- day age were, however, on the positive side of PC1, and were of higher WSN/TN%. PC2 of 60-day age could be distinguished by its higher fat and protein contents.

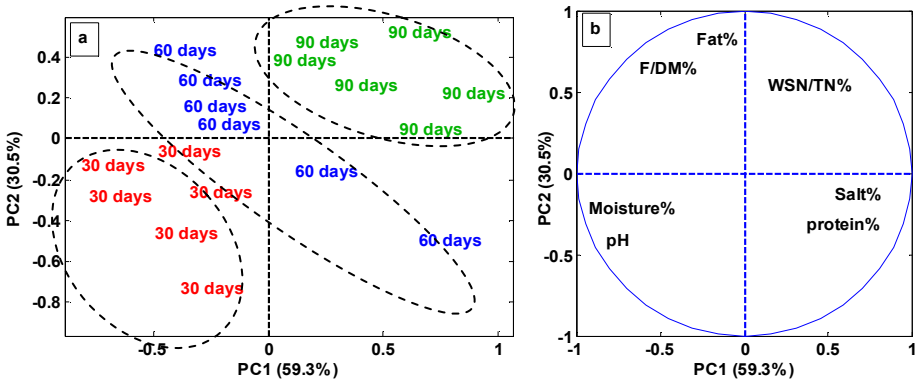

Fig 1. (a) The distribution of Ras cheese samples classified according to its age by PCA of chemical data. (b) Factor loading obtained by the first 2 PCs.

Changes in the texture primary parameters (firmness, springiness and cohesiveness), and texture secondary parameters (gumminess and chewiness) during ripening are shown in Table 2). An increase in firmness of the cheese body occurs by increasing the age. This could mainly be due to the proteolytic activity during ripening, which breaks down casein, resulting in cheese of softer, smoother-bodies Cohesiveness of Ras cheese samples tended to decrease with extending the ripening period. Such decrease may be due to the proteolytic activity, which decreases the structural firmness of the protein matrix (Romeih *et al.*, 2002). Negative correlation was established between springiness and ripening period, by reducing the springiness by extending the ripening period. This can be due to the release of calcium ions from di caclium para k-caseinate molecules being responsible for the springiness of cheese during ripening. Gumminess and chewiness values of Ras cheese increased with the prolongation of the ripening period. Similar observations were found by Olson and Johnson (1990), Romeih et al. 2002, Awad, 2006 Abd-Elmontaleb (2017.

Evaluation of rheological changes of Ras cheese by PCA was applied to the rheological data in order to detect the factors of variability during cheese ripening. The score plot and factor loading plot of PC_1 vs. PC_2, which accounted for 84.1% of the data variation, are shown in Fig.(2)

Table 2. Changes in rheological characteristics of Ras cheese during the ripening period.

Parameters	Ripening period (days)	Mean ± SD	Minium	Maximum
Firmness (N)	30	17.55 ± 6.9	11.32	32.80
	60	18.51 ± 7.5	10.74	33.28
	90	27.83 ± 6.7	19.42	39.47
Cohesiveness (~)	30	0.58 ± 0.1	0.32	0.75
	60	0.57 ± 0.1	0.40	0.77
	90	0.52 ± 0.1	0.26	0.74
Springiness (mm)	30	0.80 ± 0.1	0.66	0.92
	60	0.83 ± 0.1	0.74	0.99
	90	0.79 ± 0.1	0.67	0.89
Gumminess (N)	30	10.23 ± 4.8	4.02	18.76
	60	10.97 ± 5.6	4.98	20.51
	90	14.39 ± 5.6	6.88	25.93
Chewiness (N/mm)	30	8.06 ± 3.4	3.27	13.73
	60	9.24 ± 5.4	3.95	19.77
	90	11.34 ± 4.7	5.20	21.12

SD: standard deviations

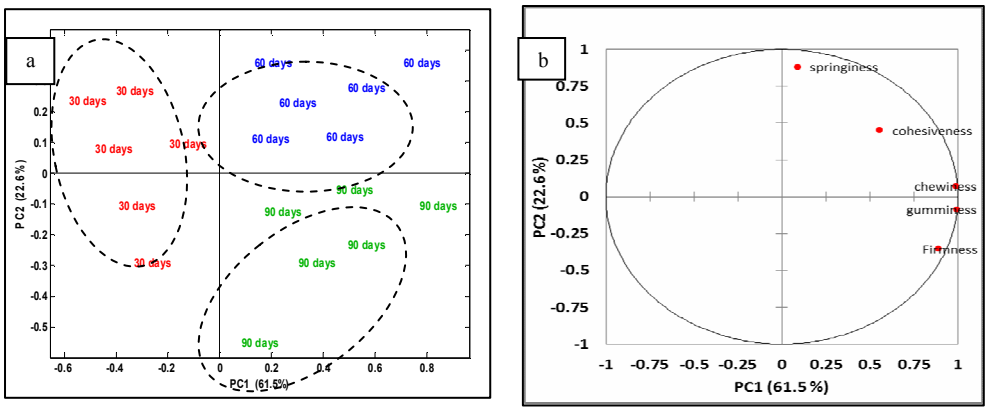

Fig. 2. (a) The distribution of Ras cheese samples classified according to its age by PCA of rheological data. (b) Factor loading obtained by the first 2 PCs.

Fig. 2 a), three groups of cheeses could be distinguished according to the stages of the ripening. Therefore, the variation in the textural property during ripening could be observed in 2 phases: the first, up to 30 days of ripening was of a higher springiness and cohesiveness values. The second phase took place after 60 days and was of a higher firmness, gumminess, and chewiness. These results are consistent with the biochemical evolution of Ras cheeses during ripening.

Changes in sensory parameter of Ras cheese during ripening are presented in Table (3). It could be seen that all cheeses were continually and gradually improved during ripening period, attaining the highest score at the end of ripening. These improvements during ripening might be attributed to the partial proteolysis of cheese, leading to softer body and texture as well as flavor enhancement (Smit *et al.*, 2005). These results are in line with the finding of Abou-Donia 2002), Smit *et al.*, 2005, Awad 2006) and Ebide (2016).

Table 3. Changes in sensory evaluation scores of Ras cheese during the ripening period.

Parameters	Ripening period (days)	Mean ± SD	Minium	Maximum
Apparence (15)	30	13.00 ± 0.8	11	13
	60	12.67 ± 0.5	12	13
	90	12.67 ± 0.5	12	13
Body & texture (35)	30	30.67 ± 0.8	30	32
	60	32.33 ± 0.8	31	33
	90	32.33 ± 0.8	31	33
Flavor (50)	30	41.00 ± 2.0	38	43
	60	43.50 ± 2.0	40	45
	90	45.33 ± 2.2	41	47
Total (100)	30	84.00 ± 3.1	79	87
	60	88.67 ± 2.1	84	91
	90	90.33 ± 2.9	85	93

SD: standard deviations

CCA was applied in order to obtain a Correlation between the chemical and rheological data by CCA. It could appear that the rheological data was highly correlated with the chemical data, the first two pairs were correlated with squared canonical correlation coefficients equal to 0.91 and 0.77 (data not shown). Similar CCA map was obtained for the chemical data to the maps of the rheological data (Fig. 3) and looked like the PCA maps for the rheological and chemical data (Fig 1 and Fig. 2). The correlation coefficients of the gumminess was of a good correlation (r = 0.90) with firmness and chewiness (r = 0.98). On the other hand, cohesiveness and springiness were not correlated with other TPA parameters and apparently were independent.

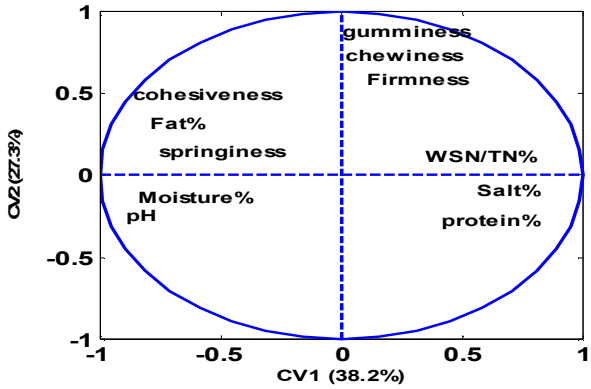

Fig. 3. CCA similarity map defined by the canonical variates 1 and 2 for the chemical and rheological data of Ras cheese.

It could also be observed in Fig. 3 that all of the analyses, the textural parameters are clustered to the right of the negative PC_1 axis. This grouping explains that this component was of overall increase in texture during ripening. On the other side of the plot, the moisture follows an opposite tendency to that of texture during cheese ripening, due to the decrease in moisture with an increasing of the cheese firmness.

CONCLUSION

PCA of Ras cheese made it possible to identify chemical and rheological changes throughout ripening period, to differentiate three groups of cheese, and to describe the ripening evolution in two steps. The first ≥ 30 days was distinguished with slight reduction in moisture, pH, and an increase in firmness, gumminess, and chewiness values. The second phase ≥ 60 days, the decrease in moisture and pH was more pronounced and characterized by an increase in cohesiveness, and decrease in firmness and gumminess due to the increase of caseins hydrolysis into small peptides.

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تقييم التغيرات في بعض الخصائص الكيميائية والريولوجية والحسية للجبن الراس خلال التسوية

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يهدف البحث إلي تقييم التغيرات الحادثة في بعض الخصائص الكيميائية والريولوجية والحسية للجبن الراس المصنعة على المستوى المحلى بمحافظة الفيوم وذلك خلال فترة تسويتها باستخدام أحد طرق التحليل الاحصائي المتقدم: طريقة تحليل العنصر الاساسي Principle Component Analysis(PCA) ، ودراسة العلاقة بين الخصائص الكيمائية والريولوجية للجبن الراس باستخدام طريقة تحليل معامل الأرتباط Canonical Correlation Analysis (CCA) ، لذا تم الاتفاق مع سته مصانع صغيرة مختلفة (بمحافظة الفيوم مختصة بتصنيع الجبن الراس) على التصنيع في يوم واحد وتم اخذ قرص من كل مصنع بعد الانتهاء من اخر خطوة تصنيعية وهي التمليح ونقلت أقراص الجبن إلى غرفة التسوية بقسم الالبان - كلية الزراعة- جامعة الفيوم وتم تقييم التغيرات خلال فترة تسويتها على درجة حرارة 12±2°م ورطوبة نسبية 88% وأخذ عينات لتحليها كيميائيا وريولوجيا وحسيا خلال مدة التسوية وهى 30، 60، 90 يوم. وقد تبين من تطبيق طريقة تحليل العنصر الاساسي على نتائج التحاليل الكيميائية والريولوجية المتحصل عليها التميز الجيد إلى ثلاث مجاميع 30 ، 60 ،90 يوم وفقا للتغيرات الحادثة في خصائها الكيميائية والريولوجية خلال فترات تسوية الجبن. فقد وجد ان المجموعة الاولى (30 يوم) تميزت بارتفاع الرطوبة والـ pH مع ارتفاع في معدل الـ Cohesiveness وانخفاض في الـ Firmness وقد حصلت على درجات منخفضة في التقييم الحسي بينما تميزت المجموعة الثالثة (90 يوم) بانخفاض الرطوبة وارتفاع نسبة الدهن والبروتين مع زيادة في معدلات كلا من الـ Firmness و Gumminess و Chewiness وقد حصلت على اعلى درجات في التقييم الحسي بينما اظهرت المجموعة الثانية (60 يوم) نتائج متوسطة ما بين المجموعتين الاولى (30 يوم) والثالثة (90 يوم) الا ان معدلات الـ Springiness كانت اعلى من المجموعتين . وهذه التغيرات تدل على مدى التطور الحادث في قوام وتركيب الجبن الراس اثناء فترة التسوية ومدى تأثير ذلك على جودة الجبن الراس وتقييم المستهلك وقد اتضح ذلك في نتائج التقييم الحسي حيث لوحظ ارتفاع درجات التقييم وخاصة القوام مع تقدم فترة تسوية الجبن. وأشارت نتائج الـ CCA إلي وجود علاقة إرتباط قوية بين نتائج تحليل الخواص الكيميائية والريولوجية والتى ينعكس على الخواص الحسية للجبن الناتج.

الكلمات الدالة : جودة الجبن الراس – قوام وتركيب الجبن – الخواص الريولوجية – طرق التحليل الإحصائي المتقدم – طريقة تحليل العنصر الاساسي.