

# Impact of Neutral Amino Acids and Sodium Dodecyl Sulphate on Ripening of Kashkaval Cheese

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Received: 25/10/2020

**Abstract:** The aim of the present study was to evaluate the impact of neutral amino acid and sodium dodecyl sulphate (SDS) on maturity of Kashkaval cheese. Results indicated that adding neutral amino acids and SDS to Kashkaval cheese curd improved the rheological and sensory properties significantly and had a good appreciated effect on cheese quality. Using mixture of asparagines and leucine increased moisture, F/DM, TN, salt/moisture, acidity, WSN, WSN/TN, TVFA, FAA and springiness while decreased pH, hardness, cohesiveness, gumminess and chewiness. Kashkaval cheese supplemented with mixture of the neutral amino acids asparagine and leucine (1 mg asparagine + 1 mg leucine/Kg curd) was considered to be superior to the control or other experimental cheese followed by cheese supplemented with 2 mg leucine/Kg curd. Furthermore, it achieved the best results for the rheological characteristics.

**Keywords:** Kashkaval cheese, neutral amino acid, cheese ripening

## INTRODUCTION

Since proteolysis is a slow process and may be a limiting factor in ripening, methods to accelerate proteolysis have attracted much interest in the recent years (Fox *et al.*, 1996). One of these methods is adding amino acids which in turn act as precursors for flavour-forming reactions to produce  $\text{NH}_3$ , amines, aldehydes, acids and alcohols which gave the specific flavor for each type of cheese (Gripon *et al.*, 1991). Flavour, texture and appearance of cheese depend basically on protein breakdown process which called proteolysis. Adding amino acids has been used to accelerate cheese proteolysis. There are only very few reports on the effects of adding amino acids to cheese curd during manufacture on the rate of flavour development. El-Safty *et al.* (1983<sub>a</sub>), stated that addition of acidic amino acids mixture improved Ras cheese flavour, but caused hardness of cheese body, while neutral amino acids mixture had a pronounced effect on improving the cheese flavour and its consistency. Basic amino acids mixture had a negligible effect on cheese flavour. They found that addition of different amino acids mixture accelerated cheese ripening. Meanwhile, El-Safty *et al.* (1989), studied the effect of adding different percentages of a mixture of acidic amino acids (asparatic acid + glutamic acid 1:1) to Ras cheese curd. The results showed that such addition of encouraged protein breakdown, accelerated cheese ripening and improved the cheese flavour but caused hardness for cheese body. Addition of disodium hydrogen phosphate with acidic amino acids mixture improved the cheese consistency. On the other hand, acidic amino acid mixture had a pronounced effect on the organoleptic properties of Domiati cheese made from reconstituted milk than the basic amino acid mixture (El-Safty *et al.*, 1983<sub>b</sub>). The addition of acidic and basic amino acids mixtures accelerated Domiati cheese ripening. Wallace and Fox (1997), supplemented Cheddar cheeses with cas-amino acids ( $0-63 \text{ mmol kg}^{-1}$ ) during manufacture. They stated that Cheeses with intermediate levels of added amino acids developed a flavour and texture superior to either the controls or the cheeses with

highest contents of cas-amino acids after a 6-month of ripening period.

Felicio *et al.* (2016), stated that sodium chloride reduction by potassium chloride (0, 25 and 50%) and addition of arginine (1% w/w) to Minas cheese represented a possibility of developing a product with good flavour and reduced sodium content.

Another method to accelerate cheese ripening is using sodium dodecyl sulphate (SDS). Depending on its ability to open the closed structure of protein and dissociate protein to its subunits (Fox, 1982). So, it can be used to accelerate the cheese ripening. Metwally and Nasr (1989) indicated that the addition of 0.05% SDS could be successfully used in the acceleration of Edam cheese ripening. Nasr and Metwally (1989), studied the addition of SDS to Romi cheese for accelerating the ripening. They reported that the addition of 0.05% SDS enhanced the growth of starter microorganisms in Romi cheese and improved the organoleptic properties. Moreover the partially effect of SDS (0.05%) on the dissociation of protein was most suitable for giving Romi cheese with highly acceptable score. Also, Farag *et al.* (1992) concluded that the addition of SDS alone or in combination with lipase enhanced the development of texture and flavour in Blue cheese and improved *Penicillium roqueforti* distribution throughout the cheese. Cheese treated with SDS (0.075%) combined with lipase greatly enhanced the development of flavour characteristics and improved body and texture and overall cheese quality.

Kashkaval is a semi-hard, yellow cheese that derives its name from the Italian cheese "*Caciocavallo*". The term *Caciocavallo* is used to describe a semi hard pasta filata cheese historically produced in various Italian regions (Succi *et al.*, 2016). Different types of *Caciocavallo* cheeses can be produced with different manufacturing technologies, varying the kind of milk used and its thermal treatment, the use of starter culture and its composition, and the curd and cheese ripening conditions, leading to products characterized by different traits (Niro *et al.*, 2014).

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The objective of this investigation was to study the impact of the addition of neutral amino acid and sodium dodecyl sulphate (SDS) on maturity of kashkaval cheese and to evaluate the chemical, rheological and sensory properties of cheese during the ripening period.

## MATERIALS AND METHODS

### Materials:

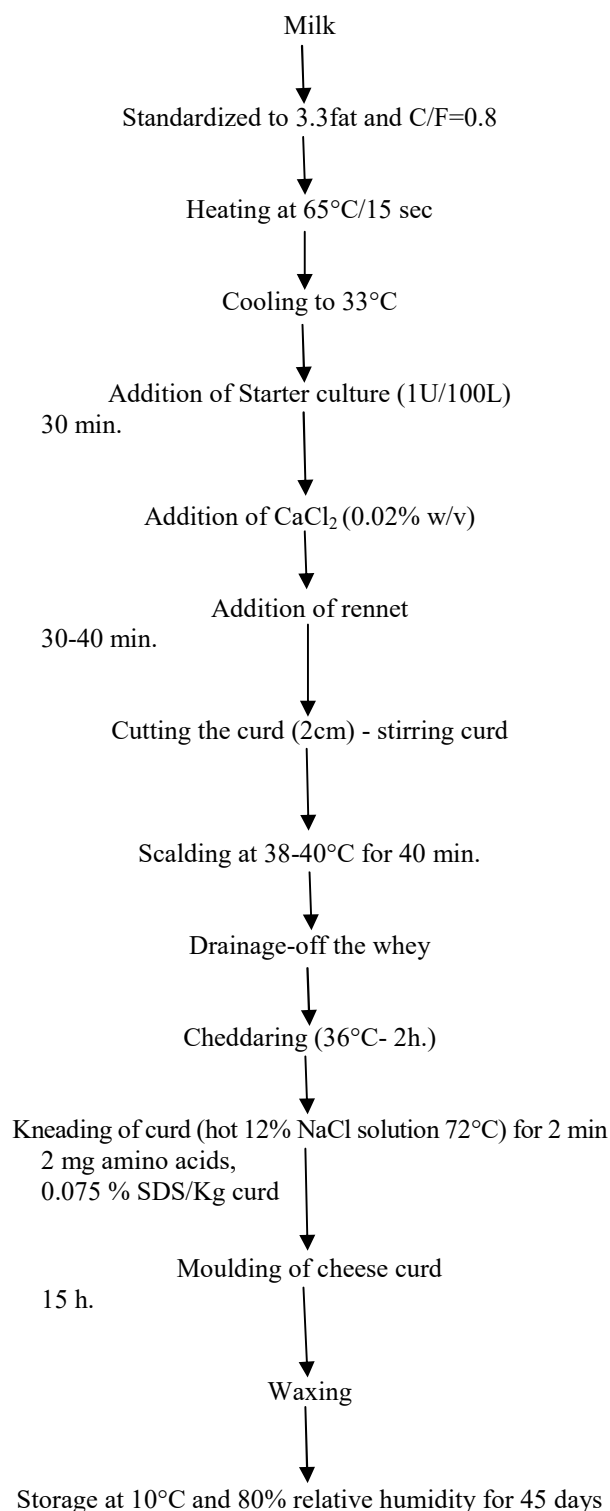
Fresh Cow's and buffalo's milk were obtained from the herd of Faculty of Agriculture, Suez Canal University, Ismailia governorate. Yoghurt culture containing *Streptococcus thermophiles* and *Lactobacillus delbrueckii* spp. *bulgaricus* (DVS) was obtained from Chr-Hansen's laboratories, Denmark. Rennet powder, CHY-MAX was obtained from Chr-Hansen's laboratories, Denmark. Commercial salt was obtained from the local market. Amino acids, sodium dodecyl sulphate and calcium chloride were obtained from El-Naser pharmaceutical and chemical company, Cairo governorate, Egypt.

### Experimental procedure:

Five treatments were carried out. All treatments were made from mixture of buffalo's and cow's milk (1:1) standardized to 3.3 % fat, 11.8% TS, 2.63% casein and 0.8 C/F. Treatment 1 (T1) serves as full fat control Kashkaval cheese. Treatment 2 (T2) was made by adding 2 mg asparagine/Kg curd, Treatment 3(T3) was made by adding 2 mg leucine/Kg curd, Treatment 4 (T4) was made by adding mix of 1 mg asparagine + 1 mg leucine/Kg curd while, Treatment 5 (T5) was made by adding 0.075% sodium dodecyl sulphate (SDS) to the cheese curd. Kashkaval cheese was manufactured as described by Simov and Ivanov (2005) as shown in Fig. (1). The resultant cheese was stored for 45 days at 10°C and 80% relative humidity. The whole experiment was thrice.

### Methods of analysis:

Analysis of cheese milk (Total solids, Fat and Casein content) was carried out according to the methods described in AOAC (2007). Cheese samples were analyzed chemically when fresh and after 15, 30 and 45 days of ripening. Moisture content, water soluble nitrogen (WSN) and total nitrogen content (TN) were measured by Kjeldahl method using semi-micro Kjeldahl according to the methods described by AOAC (2007). Acidity was determined by the titration method according to Vujicic *et al.* (1996). pH value was measured by using (Jenway digital pH meter, Jenway Limited, England). Salt content was determined according to Volhard method and fat content by Gerber butyrometer as described by Ling (1963). Free amino acids value (expressed as Absorbance at 507 nm/100µl WSN) was estimating using cadmium-ninhydrin method as described by Folkertsma and Fox (1990). Total volatile fatty acids contents (TVFA) were estimated by the distillation method according to Kosikowski (1982). Values were expressed as ml of 0.1 N NaOH/100 gm cheese.



**Fig. (1):** Flow sheet of Kashkaval cheese manufacture.

### Rheological properties:

Texture profile analysis test of cheese samples (which shape was 2×2×2 cylindrical) was done using a Universal Testing Machine (TMS-Pro) Food Technology Corporation, Sterling, Virginia, USA) equipped with 1000 N (250 lbf) load cell and connected to a computer programmed with Texture Pro™ texture analysis software (program, DEV TPA With holding time between cycle two second). A flat rod probe (49.95

mm in diameter) to uniaxially compress the “cheese samples with the following parameters conduction to 30% of their original height. Each sample was subjected to two subsequent cycles (bites) of compression-decompression. Data were collected on computer and the texture profile parameters were calculated from DEV TPA texture analyzer and computer interface. Calculation described by Szczesniak *et al.* (1963), Bourne (1978) was used to obtain the following texture profile parameters (Hardness, Cohesiveness, Springiness, Gumminess and Chewiness). The rheological characteristics were determined when fresh, 15 and 45 days of storage.

#### Sensory evaluation:

The sensory evaluation of cheese samples was carried out according to the method of Pappas *et al.* (1996) when fresh and after 15, 30 and 45 days of storage with maximum score points for flavour (50 points), body and texture (40 points) and appearance and colour (10 points). The sensory evaluation was carried out by 15 members of Dairy Department, Faculty of Agriculture, Suez Canal University.

#### Statistical analysis:

All measurements were done in triplicate and analysis of variance with two factorial (treatments and storage period) were conducted by the procedure of General Linear Model (GLM) using CoStat (1998) under windows software version 6.311 and least significant differences (LSD) test were employed to determine significant difference at  $p < 0.05$ .

## RESULTS AND DISCUSSION

#### Gross Chemical Composition:

Table (1) shows the averages of moisture contents of Kashkaval cheese treatments. It can be seen that the moisture content of treatment 4 (T4) was higher ( $p \leq 0.05$ ) than the other treatments. Felicio *et al.* (2016) found that adding arginine to Minas cheese increased the moisture content due to the effect of arginine on water holding capacity in the cheese matrix, they also explained that amino acids are able to establish chemical bonds with water and other cheese component. Using SDS in treatment 5 (T5) decreased markedly ( $p \leq 0.05$ ) the moisture content of cheese of different ages. In contrast to these results, Nasr and Metwally (1989) reported that using SDS in Romi cheese making had a negligible effect on moisture content. On the other hand, the moisture content of all treatments showed a marked ( $p \leq 0.05$ ) decrease throughout the storage period. Similar results were also observed by Gobbetti *et al.* (2002), Santa and Srbinovska (2014).

It can be seen from values given in Table (1), fat on dry matter (F/DM) increased significantly ( $p \leq 0.05$ ) by using neutral amino acids. While, using SDS did not affect F/DM (T5) as compared to control cheese (T1). This was noticed in fresh and during cheese ripening. It was noticed that F/DM content of all treatments increased significantly ( $p \leq 0.05$ ) as storage progressed. These variations may be due to the changes in moisture content of different cheese treatments during storage.

Similar results were observed by Santa and Srbinovska (2014).

According to the obtained results (Table 1), total nitrogen content (TN) of treatment 4 (T4) was significantly ( $p \leq 0.05$ ) higher than the other treatments when fresh and throughout the storage period. The TN values increased significantly ( $p \leq 0.05$ ) among all treatments with advanced storage. This increase might be due to loss of moisture content during the storage period. These results are in agreement with Abd El-Gawad *et al.* (2007), Santa and Srbinovska (2014), Talevski *et al.* (2017). Salt on moisture (S/M%) increased significantly ( $p \leq 0.05$ ) by adding neutral amino acids, while adding SDS decreased remarkably ( $p \leq 0.05$ ) the salt on moisture. Treatment 4 (T4) had the highest ( $p \leq 0.05$ ) salt/moisture percentage as compared to the other treatments. During the ripening period, salt/moisture increased markedly ( $p \leq 0.05$ ) as a result of the decrease in moisture content. These results concur with those reported by Santa and Srbinovska (2014).

The changes in acidity and pH values of Kashkaval cheese as affected by the applied treatments and during the storage time are presented in Table (1). It was noticed that the titratable acidity increased when neutral amino acids (asparagine- leucine) were used, while there is no significant ( $p > 0.05$ ) differences between treatment 2 (cheese treated with 2 mg asparagines) and 3 (cheese treated with 2 mg leucine). El-Safty *et al.* (1983a), Abu-El nour (1987) reported the same results with Ras cheese. The titratable acidity of treatment 5 was higher than control (T1). This result may be due to the direct effect of SDS as ionic salt or to the indirect effect of SDS as responsible for the disassociation of casein micelles (Fox, 1982). These results are in agreement with Nasr and Metwally (1989). There are no significant ( $p > 0.05$ ) differences in pH values between treatments. Also, it was noticed that there was a continuous increase in acidity and a decrease in pH values during the storage period for all cheese treatments. These results are in agreement with Santa and Srbinovska (2014).

#### Ripening indices:

The water soluble nitrogen (WSN) and water soluble nitrogen coefficient (WSN/TN) increased significantly ( $p \leq 0.05$ ) as neutral amino acids and SDS were used (Table 2). Treatment 4 had the highest ( $p \leq 0.05$ ) value of WSN and water soluble nitrogen coefficient followed by treatment 3 as compared with control cheese and the other treatments. These results are in agreement with Abu-El Nour (1987), Wallace and Fox (1997). The obtained result showed that SDS treated cheese at level 0.075% had higher values of WSN and WSN/TN than control cheese. These results could be explained on the basis that added SDS denatured and dissociation the protein substrates into their subunits (Fox, 1982).

The WSN and WSN/TN percentages increased significantly ( $p \leq 0.05$ ) as storage progressed. Similar results were reported by Niro *et al.* (2014), Talevski *et al.* (2017). Concerning the total volatile fatty acids (TVFA), It is clear that the addition of neutral amino

acids affected significantly ( $p \leq 0.05$ ) TVFA content. Abu-El Nour (1987) reported that addition of mixture of acidic amino acids to cheese curd accelerated fat hydrolysis in Ras cheese along the ripening period. Adding SDS increased TVFA values when fresh and during the storage period. This is in agreement with Nasr and Metwally (1989) who found that addition of SDS to Romi cheese increased TVFA values.

Also, Farag *et al.* (1992) stated that addition of SDS to blue cheese curd enhanced the formation of free fatty acids during ripening. All treatments had a significant ( $p \leq 0.05$ ) increase values of TVFA during storage period. These results are in agreement with Hassan (2005), Abd El-Gawad *et al.* (2007). This increment during the storage time may be due in part to the residual activity of heat resistance lipase which may cause the fat hydrolysis (Mansour, 2005).

**Table (1):** Effect of using neutral amino acids and sodium dodecyl sulphate (SDS) on gross chemical composition of Kashkaval cheese during ripening period (Average of three replicates)

Treatments	Storage Period (days)				Mean
	Moisture content (%)				
	Fresh	15	30	45	
T1	45.10	43.68	43.13	42.69	43.64 <sup>C</sup>
T2	45.15	43.71	43.22	42.70	43.70 <sup>BC</sup>
T3	45.23	43.75	43.29	42.75	43.76 <sup>B</sup>
T4	45.35	43.82	43.32	42.82	43.83 <sup>A</sup>
T5	44.9	43.55	42.97	42.50	43.52 <sup>D</sup>
Mean **	45.15 <sup>a</sup>	43.70 <sup>b</sup>	43.18 <sup>c</sup>	42.73 <sup>d</sup>	
*F/DM%					
T1	46.08	46.52	46.95	47.11	46.67 <sup>D</sup>
T2	46.13	46.72	47.20	47.47	46.88 <sup>C</sup>
T3	46.38	46.76	47.43	47.69	47.07 <sup>B</sup>
T4	46.48	46.99	47.46	47.92	47.21 <sup>A</sup>
T5	46.10	46.59	46.82	47.30	46.70 <sup>D</sup>
Mean **	46.23 <sup>d</sup>	46.72 <sup>c</sup>	47.17 <sup>b</sup>	47.50 <sup>a</sup>	
*TN%					
T1	4.11	4.30	4.36	4.41	4.30 <sup>D</sup>
T2	4.14	4.35	4.39	4.44	4.33 <sup>BC</sup>
T3	4.15	4.38	4.42	4.46	4.35 <sup>B</sup>
T4	4.17	4.41	4.45	4.49	4.38 <sup>A</sup>
T5	4.12	4.32	4.37	4.43	4.31 <sup>CD</sup>
Mean **	4.14 <sup>d</sup>	4.35 <sup>c</sup>	4.40 <sup>b</sup>	4.45 <sup>a</sup>	
*S/M_%					
T1	2.84	2.99	3.18	3.35	3.09 <sup>D</sup>
T2	2.86	3.04	3.16	3.37	3.11 <sup>C</sup>
T3	2.92	3.13	3.30	3.49	3.21 <sup>B</sup>
T4	2.93	3.19	3.37	3.53	3.26 <sup>A</sup>
T5	2.83	2.99	3.16	3.32	3.08 <sup>E</sup>
Mean **	2.88 <sup>d</sup>	3.07 <sup>c</sup>	3.23 <sup>b</sup>	3.41 <sup>a</sup>	
Acidity%					
T1	0.90	1.19	1.21	1.26	1.14 <sup>D</sup>
T2	0.92	1.23	1.27	1.32	1.19 <sup>B</sup>
T3	0.95	1.24	1.27	1.33	1.20 <sup>B</sup>
T4	0.95	1.26	1.29	1.36	1.22 <sup>A</sup>
T5	0.92	1.21	1.23	1.29	1.16 <sup>C</sup>
Mean	0.93 <sup>d</sup>	1.23 <sup>c</sup>	1.25 <sup>b</sup>	1.31 <sup>a</sup>	
pH					
T1	5.40	5.31	5.30	5.26	5.32 <sup>A</sup>
T2	5.36	5.29	5.27	5.24	5.29 <sup>AB</sup>
T3	5.33	5.29	5.26	5.22	5.28 <sup>AB</sup>
T4	5.33	5.27	5.24	5.20	5.26 <sup>B</sup>
T5	5.35	5.30	5.28	5.25	5.30 <sup>AB</sup>
Mean **	5.35 <sup>a</sup>	5.29 <sup>b</sup>	5.27 <sup>bc</sup>	5.23 <sup>c</sup>	

T1: control, T2: 2 mg asparagine/Kg curd, T3: 2 mg leucine/Kg curd, T4: 1 mg asparagine + 1 mg leucine /Kg curd, T5: 0.075 % SDS.

\*F/DM: fat on dry matter \*TN: total nitrogen \*S/M: salt on moisture

\*\*a, b & c and A, B, C & D: means with the same letters among treatments and storage period respectively are not significantly different ( $p > 0.05$ )

**Table (2):** Effect of using neutral amino acids and sodium dodecyl sulphate (SDS) on water soluble nitrogen (WSN %), water soluble nitrogen coefficient and total volatile fatty Acids (TVFA)\* of Kashkaval cheese during storage (Average of three replicates)

Treatments	Storage period (days)				Mean
	Fresh	15	30	45	
<b>WSN %</b>					
T1	0.220	0.311	0.439	0.552	0.381 <sup>E</sup>
T2	0.234	0.327	0.444	0.561	0.392 <sup>C</sup>
T3	0.236	0.330	0.449	0.566	0.395 <sup>B</sup>
T4	0.239	0.335	0.455	0.572	0.400 <sup>A</sup>
T5	0.231	0.321	0.441	0.557	0.388 <sup>D</sup>
Mean**	0.232 <sup>d</sup>	0.325 <sup>c</sup>	0.446 <sup>b</sup>	0.562 <sup>a</sup>	
<b>WSN/TN%</b>					
T1	5.35	7.23	10.07	12.52	8.79 <sup>E</sup>
T2	5.65	7.51	10.11	12.64	8.98 <sup>C</sup>
T3	5.69	7.53	10.16	12.69	9.02 <sup>B</sup>
T4	5.73	7.59	10.22	12.74	9.07 <sup>A</sup>
T5	5.61	7.43	10.09	12.57	8.93 <sup>D</sup>
Mean**	5.61 <sup>d</sup>	7.46 <sup>c</sup>	10.13 <sup>b</sup>	12.63 <sup>a</sup>	
<b>*TVFA</b>					
T1	2.6	5.8	8.2	8.6	6.3 <sup>E</sup>
T2	2.6	6.5	8.5	9.0	6.7 <sup>C</sup>
T3	2.7	6.7	8.9	9.3	6.9 <sup>B</sup>
T4	2.7	7.0	9.5	9.8	7.3 <sup>A</sup>
T5	2.6	6.0	8.3	8.7	6.4 <sup>D</sup>
Mean**	2.6 <sup>d</sup>	6.4 <sup>c</sup>	8.7 <sup>b</sup>	9.1 <sup>a</sup>	

See Table (1) for treatments designation

\*TVFA expressed as ml 0.1 N NaOH / 100g cheese.

\*\*a, b, c & d and A, B, C, D & E: means with the same letters among treatments and storage period respectively are not significantly different ( $p > 0.05$ )

### Free Amino Acids formation (FAA):

The evolution of free amino acids (FAA) of Kashkaval cheese as affected by neutral amino acids and SDS is shown in Table (3). Adding neutral amino acids increased the absorbance values of FAA significantly ( $p \leq 0.05$ ). Wallace and Fox (1997) found the same results for Cheddar cheese. Also using SDS increased FAA significantly ( $p \leq 0.05$ ) as compared with the control cheese (T1). This may be due to the effect of SDS on the dissociation of casein into their subunits (Fox 1982). Kashkaval cheese made with adding

mixture of neutral amino acids (T4) gave the highest ( $p \leq 0.05$ ) values of FAA followed by cheese made using leucine (T3) whereas control cheese had the lowest ( $p \leq 0.05$ ) concentration of FAA. These results are consistent with the results of WSN prementioned in cheese from treatments (T4 and T3). Concentration of free amino acid increased pronouncedly ( $p \leq 0.05$ ) during storage. These results are consistent with the determination of WSN, which increased in all cheese throughout ripening period.

**Table (3):** Changes in free amino acids (expressed as A507) during ripening of Kashkaval cheese as affected by using neutral amino acids and sodium dodecyl sulphate (SDS) (Average of three replicates)

Treatments	Storage period (days)				Mean
	Fresh	15	30	45	
T1	0.017	0.059	0.93	0.166	0.084 <sup>E</sup>
T2	0.024	0.065	0.104	0.175	0.092 <sup>C</sup>
T3	0.027	0.073	0.118	0.193	0.103 <sup>B</sup>
T4	0.051	0.101	0.147	0.219	0.130 <sup>A</sup>
T5	0.023	0.061	0.102	0.171	0.089 <sup>D</sup>
Mean	0.028 <sup>d</sup>	0.072 <sup>c</sup>	0.113 <sup>b</sup>	0.185 <sup>a</sup>	

See Table (1) for treatments designation

\*\*a, b, c & d and A, B, C, D & E: means with the same letters among treatments and storage period respectively are not significantly different ( $p > 0.05$ )

### Rheological Characteristics:

Cheese rheology can be described as the study of cheese deformation and flow under stress or strain. This behavior related to the cheese composition, microstructure and macrostructure (Fox *et al.*, 2017).

### Hardness:

Fox *et al.* (2000), defined hardness as high resistance to deformation by applied stress. Data presented in Table (4) indicated that adding neutral amino acids decreased the hardness significantly ( $p \leq 0.05$ ). The highest and the lowest hardness values were related to T1 and T4 respectively. Adding SDS in

treatment 5 decreased the hardness markedly ( $p \leq 0.05$ ) as compared to control cheese (T1). During the storage period, the hardness of all cheese samples increased pronouncedly ( $p \leq 0.05$ ) up to the day 15 and then decreased at the end of the ripening. The hardness related to the moisture content so, when the moisture decreased the hardness increased. The decrease in hardness at the end of the storage period is related to cheese proteolysis. The increase in hardness during ripening might a result from the reduction in the level of free water, which increases cheese resistance to deformation (Beal. and Mittal, 2000).

**Table (4):** Effect of using neutral amino acids and sodium dodecyl sulphate (SDS) on hardness, Springiness and Cohesiveness of Kashkaval cheese during ripening periods (Average of three replicates)

Treatments	Storage Period (days)			Mean
	Fresh	15	45	
<b>Hardness (N)</b>				
T1	18.8	33.3	23.40	25.17 <sup>A</sup>
T2	18.0	32.5	22.70	24.4 <sup>C</sup>
T3	17.6	32.0	22.60	24.07 <sup>D</sup>
T4	17.1	31.2	22.00	23.43 <sup>E</sup>
T5	18.2	32.87	23.10	24.72 <sup>B</sup>
Mean **	17.94 <sup>c</sup>	32.37 <sup>a</sup>	22.76 <sup>b</sup>	
<b>Springiness (mm)</b>				
T1	4.25	1.95	1.68	2.63 <sup>E</sup>
T2	4.39	2.00	1.77	2.72 <sup>C</sup>
T3	4.48	2.02	1.80	2.77 <sup>B</sup>
T4	4.51	2.15	1.93	2.86 <sup>A</sup>
T5	4.33	1.98	1.74	2.68 <sup>D</sup>
Mean **	4.39 <sup>a</sup>	2.02 <sup>b</sup>	1.78 <sup>c</sup>	
<b>Cohesiveness (Ratio)</b>				
T1	0.69	0.86	0.72	0.76 <sup>A</sup>
T2	0.65	0.82	0.68	0.72 <sup>C</sup>
T3	0.64	0.80	0.66	0.70 <sup>D</sup>
T4	0.54	0.73	0.59	0.62 <sup>E</sup>
T5	0.67	0.84	0.70	0.74 <sup>B</sup>
Mean **	0.64 <sup>c</sup>	0.81 <sup>a</sup>	0.67 <sup>b</sup>	

See Table (1) for treatments designation

\*\*a, b & c and A, B, C, D & E: means with the same letters among treatments and storage period respectively are not significantly different ( $p > 0.05$ )

### Springiness and Cohesiveness:

Springiness defined as rate at which deformed food returns to original condition after removal force (Tunick, 1999; Fox *et al.*, 2000). It can be noticed that the control kashkaval cheese (T1) had the lowest ( $p \leq 0.05$ ) springiness value among all treatments, while treatment 4 had the highest ( $p \leq 0.05$ ) springiness value (Table 4). This may be related to the hardness values. Adding neutral amino acids and SDS increased markedly ( $p \leq 0.05$ ) springiness values compared to control (T1). In all treatments springiness values decreased remarkably ( $p \leq 0.05$ ) during the ripening period. This may be due to the breakdown of protein matrix which dependent on some factors such as moisture and fat content of cheese (El-Zeini *et al.*, 2007).

Cohesiveness, measures of tendency of cheese to remain together and resist breaking into several pieces, during compression (Fox *et al.*, 2017). It is clear that treatment (T4) had the lowest ( $p \leq 0.05$ ) value of cohesiveness while treatment (T1) had the highest ( $p \leq 0.05$ ) value. Adding neutral amino acids and SDS decreased ( $p \leq 0.05$ ) the cohesiveness. During ripening periods, the cohesiveness increased up to 15 days then decreased by the end of ripening. Proteolysis disrupts the structural integrity of the protein matrix, leading to reduced cohesiveness (Beal and Mittal, 2000). Proteolysis was higher in the less cohesive cheeses.

### Gumminess and Chewiness:

Gumminess defined as force needed to disintegrate a semisolid food to a state ready for Swallowing (Tunick, 1999). Control Kashkaval cheese (T1) had the highest ( $p \leq 0.05$ ) value of gumminess than

the other treatments while, treatment 4 had the lowest ( $p \leq 0.05$ ) value (Table 5). This may be due to the high hardness value of treatment (T1) and the lowest ( $p < 0.05$ ) hardness value of treatment 4 (T4). Adding neutral amino acids and SDS decreased significantly ( $p \leq 0.05$ ) the gumminess of Kashkaval cheese. This may be due to the reduction of hardness by adding neutral amino acids and SDS. Gumminess of all treatments increased significantly ( $p \leq 0.05$ ) up to 15 days and then decreased significantly at the end of ripening period.

In terms of chewiness, it can be noticed from Table (5) that the chewiness values of treatment (T1) was higher ( $p \leq 0.05$ ) than those of the other treatments. This may be due to the higher hardness value of

treatment (T1). On the other hand (T4) exhibit the lowest ( $p \leq 0.05$ ) chewiness value compared to other treatments. This result may be due to the lowest hardness value of treatment (T4). Adding neutral amino acids and SDS decreased the chewiness of Kashkaval cheese. This may be due to the reduction of hardness by adding neutral amino acids and SDS.

As chewiness, work needed to masticate a solid food to a state ready for swallowing (Tunick, 1999). There is a correlation between hardness and chewiness, harder cheese is more difficult to chew (Beal and Mittal, 2000). Chewiness of all treatments increased significantly ( $p \leq 0.05$ ) up to 15 days and then decreased significantly at the end of ripening period.

**Table (5):** Effect of using neutral amino acids and sodium dodecyl sulphate (SDS) on the Gumminess and Chewiness of Kashkaval cheese during ripening periods (Average of three replicates)

Treatments	Storage Period (days)			Mean
	Fresh	15	45	
<b>Gumminess (N)</b>				
T1	12.97	28.64	16.85	19.49 <sup>A</sup>
T2	11.70	26.65	15.44	17.93 <sup>C</sup>
T3	11.26	25.6	14.92	17.26 <sup>D</sup>
T4	9.23	22.78	12.98	14.99 <sup>E</sup>
T5	12.19	27.61	16.17	18.66 <sup>B</sup>
Mean **	11.47 <sup>c</sup>	26.26 <sup>a</sup>	15.27 <sup>b</sup>	
<b>Chewiness (N)</b>				
T1	55.12	55.85	28.31	46.43 <sup>A</sup>
T2	51.36	53.30	27.33	44.00 <sup>C</sup>
T3	50.44	51.70	26.86	43.00 <sup>D</sup>
T4	41.63	48.98	25.05	38.55 <sup>E</sup>
T5	52.78	54.67	28.14	45.20 <sup>B</sup>
Mean **	50.27 <sup>b</sup>	52.90 <sup>a</sup>	27.14 <sup>c</sup>	

See Table (1) for treatments designation

\*\*a, b & c and A, B, C, D & E: means with the same letters among treatments and storage period respectively are not significantly different ( $p > 0.05$ )

### Sensory evaluation:

The addition of neutral amino acids and SDS to kashkaval cheese improved the flavour, the body & texture and overall acceptability. These results are in accordance with Nasr and Metwally (1989), Wallace and Fox (1997). As shown in Table (6), treatment 4 gained the highest ( $p \leq 0.05$ ) score points for flavour, body & texture, and overall acceptability either when fresh or during storage period. Same results were reported by Felicio *et al.* (2016) who found that the addition of arginine positively affected probiotic Minas cheese flavour. In general for all cheeses total score points were higher for 45 days old cheeses as compared with fresh cheeses. It is well known that degradation of casein improves both texture and flavour. It was noticed that treatment 4 which has a mixture of asparagine and leucine gained the highest ( $p \leq 0.05$ ) score for all sensory properties among all treatments when fresh and

throughout storage period. Addition of mixture of neutral amino acids (asparagine and leucine) to kashkaval cheese curd enhanced the development of flavour characteristics and improved body and texture more than all the other treatments. These results could be attributed to the increased accumulation of nitrogenous compounds and total free fatty acids and formation of carbonyl compounds (Farag *et al.*, 1992).

From the above results it could be concluded that adding neutral amino acids and SDS to kashkaval cheese curd improved the sensory and rheological properties significantly and had a good appreciated effect on cheese quality. The cheese supplemented with mixture of the neutral amino acids asparagine and leucine (1 mg asparagine + 1 mg leucine/Kg curd) was considered by the graders to be superior to the control or other experimental cheese followed by cheese supplemented with 2 mg leucine/Kg curd.

**Table (6):** Effect of using neutral amino acids and sodium dodecyl sulphate (SDS) on the organoleptic properties of Kashkaval cheese during ripening periods

Treatment	Storage period (days)				Mean
	Fresh	15	30	45	
<b>Flavour (50 points)</b>					
T1	29	33	43	46	37.8 <sup>D</sup>
T2	30	35	44	46	38.8 <sup>C</sup>
T3	33	37	46	47	40.8 <sup>B</sup>
T4	36	40	47	49	43.0 <sup>A</sup>
T5	30	34	44	45	38.3 <sup>CD</sup>
Mean**	31.6 <sup>d</sup>	35.8 <sup>c</sup>	44.8 <sup>b</sup>	46.6 <sup>a</sup>	
<b>Body &amp; Texture (40 points)</b>					
T1	25	28	32	35	30.0 <sup>C</sup>
T2	26	30	34	37	31.8 <sup>b</sup>
T3	26	30	35	37	32.0 <sup>B</sup>
T4	26	32	37	39	33.5 <sup>A</sup>
T5	26	29	34	37	31.5 <sup>B</sup>
Mean**	25.8 <sup>d</sup>	29.8 <sup>c</sup>	34.4 <sup>b</sup>	37.0 <sup>a</sup>	
<b>Appearance and colour (10 points)</b>					
T1	8	8	9	9.5	8.6 <sup>A</sup>
T2	8	8	9	9.5	8.6 <sup>A</sup>
T3	8	8	9	9.5	8.6 <sup>A</sup>
T4	8	8	9	9.5	8.6 <sup>A</sup>
T5	8	8	9	9.5	8.6 <sup>A</sup>
Mean**	8.0 <sup>c</sup>	8.0 <sup>c</sup>	9.0 <sup>b</sup>	9.5 <sup>a</sup>	
<b>Overall acceptability (100 points)</b>					
T1	62	69	84	90.5	76.4 <sup>E</sup>
T2	64	73	87	92.5	79.1 <sup>C</sup>
T3	67	75	90	93.5	81.4 <sup>B</sup>
T4	70	80	93	97.5	85.1 <sup>A</sup>
T5	64	71	87	91.5	78.4 <sup>D</sup>
Mean**	65.4 <sup>d</sup>	73.6 <sup>c</sup>	88.2 <sup>b</sup>	93.1 <sup>a</sup>	

See Table (1) for treatments designation

\*\*a, b, c & d and A, B, C, D & E: means with the same letters among treatments and storage period respectively are not significantly different ( $p > 0.05$ )

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## تأثير الأحماض الأمينية المتعادلة ودودييسيل كبريتات الصوديوم على تسوية جبن الكشكفال

محمد سميح الصفتى ، عاطف محمد أبو النور ، أميرة محمد الخولى ، رفيق عبد الرحمن خليل ، صفاء محمود مقبل  
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تهدف هذه الدراسة تقييم تأثير الأحماض الأمينية المتعادلة و دودييسيل كبريتات الصوديوم (SDS) على تسوية جبن الكشكفال. أشارت النتائج إلى أن إضافة الأحماض الأمينية المتعادلة و SDS إلى خثرة جبن الكشكفال أدى إلى تحسين الخصائص الحسية والريولوجية بشكل كبير وكان له تأثير جيد على جودة الجبن. أدى استخدام مزيج من الأسباراجين والليوسين إلى زيادة نسبة الرطوبة، نسبة الدهن بالنسبة للمادة الجافة، النيتروجين الكلى، الملح منسوبا للمحتوى المائى، نسبة الحموضة، النيتروجين الذائب، النيتروجين الذائب منسوبا إلى النيتروجين الكلى، الأحماض الدهنية الطيارة الكلية، الأحماض الامينية الحرة والمرونة مع انخفاض الأس الهيدروجينى، والصلابة، والتماسك، والتصمغ، والمضغ. اعتبر المحكمون أن جبن الكشكفال المضاف إليه مخلوط من الأحماض الأمينية المتعادلة الأسباراجين والليوسين (1 مجم أسباراجين + 1 مجم ليوسين/كجم خثرة) أفضل من الجبن المقارن أو معاملات الجبن المختبرة الأخرى متبوعًا بالجبن المضاف إليه 2 مجم ليوسين/كجم خثرة.