J. Food and Dairy Sci., Mansoura Univ., Vol. 5 (11): 827 -840, 2014

STARCH AND OTHER STABILIZERS COMBINATIONS ASTHICKENING AGENTS IN PROCESSED CHEESE SAUCES MANUFACTURE

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ABSTRACT

Production of different processed cheese sauces using corn starch (CS)and sodium alginate (SA) or guar gum (GG) as thickening agents were successfully achieved. Thus, 6 treatments were manufactured containing the combination: 1 : 1 means 1.5 % corn starch + 0.25 % (guar gum or sodium alginate), 2 : 1 means 2.0 % corn starch + 0.16 % (guar gum or sodium alginate) and 1 : 2 means 1.0 % corn starch + 0.33 % (guar gum or sodium alginate). Processed cheese sauce blends were adjusted to contain 25 % dry matter, 40 % F / DM in the finished product of processed cheese sauce.There were a slight and non-significant differences in the pH values, and the average of all treatments was 5.82. Addition of corn starch and sodium alginate or guar gum mixtures in the processed cheese sauces formulas was of different effects on the oil separation index values of the resultant processed cheese sauces with sodium alginate or even with guar gum.The differences in viscosity values among treatments with different stabilizing mixtures could be due to difference in the ability of each stabilizer to bind water.

All of the resultant cheese sauces were evaluated when fresh for chemical composition. Treatments were also examined for pH, SN, oil separation index, viscosity and sensory properties, when fresh and after 1 & 3 months of storage either at (5 ± 2 ºC) or at (25 ± 2 ºC). Three replicates were carried out for each treatment, and the data obtained were statistically analyzed at $p \leq 0.05$.

INTRODUCTION

Cheese has been widely used as an ingredient in various foods, formulated foods and prepared meals since the first recorded consumption of cheese itself, mainly to add flavor to bland foods, texture, and nutritional quality.In addition to the “Heat is on ”trend, some formulators of sauces may be simultaneously going after the indulgence trend, creating products that may “ cream ” traditional varieties. For example, liquid sauces combing heat with creaminess, have been developed by newly weds foods. Nowadays, consumer demand for a wider range of more sophisticated foods is reflected in the greater variety of cheeses now available.Cheese sauce is a product of cheese have a specific characters and can be made by different industrial methods in different ways.Cheese sauce is a novel cheese product nowadays, not only for being attractive appetizer but also for being perceived as a first course or a side dish and rather as an ingredient entire, meant to stand by itself.Cheese sauces may be used for dipping, topping, or grilling and other applications like coatings which can replace the need for

consumer to add their own sauces to seafood, chicken and beef, making meal preparation faster and easier.Most of cheese sauce varieties in the market are including cheese as cheese powder or just cheese flavour. Blends of natural cheeses can attribute special natural flavours. Best smoother texture in a processed cheese sauces and more uniform particle sizes and flowable end product resulted from the cheese power.Effective method of lowering manufacturing costs of producing cheese sauces is to lower the levels of cheese solids. Least cost formulas are made with a cheese content ranging from about 2 – 13 % by weight based on the weight of the sauce, while the higher quality " premium " formulas call for cheese content ranging from above 13 – 30% by weight based on the weight of the sauce. A number of patents relating to the use of thickening agents and starches as casein substitutes in imitation cheese have been issued.The use of stabilizers in combinations in sauces can provide greater stability for the food formulator. Stabilizers suits for mild to moderate processing conditions, provides rapid, high viscosity development and imparts excellent cold temperature storage stability. Sauces made with stabilizers usually exhibit smooth and creamy mouth feel, shelf stable and high quality.Corn starch was found to be one of the best starches with the advantages that, it is cheap and can easily be obtained, Moreover preferred for low acid heat sterilized sauces as well as adding whiteness and opacity. guar gum or sodium alginate when used produced cheese sauces with highest quality attributes. Since the cheese sauce is not well established in Egyptian market even it can be a very good appetizer. This study was planned to successfullyoffer delicious and favourable cheese sauce formulas with highly acceptable quality to be suitable for Egyptian consumers. On the other hand, to investigate the effect of processed cheese sauces formulations not only by using thickening systems in different mixtures and available raw materials in Egyptian market but also to produce a processed cheese sauce with acceptable moisture / texture profile, shelf stable and high quality attributes.

MATERIALS AND METHODS

Ras cheese was purchased from the local market, Cairo, Egypt. Skim milk powder was obtained from Dina farmer, Cairo, Egypt. Corn starch was obtained from the Starch and Glucose Company, Cairo, Egypt. Sodium alginate was obtained from Misr for Food Additives (MIFAD), Giza, Egypt. Guar gum obtained from Gumix International, Inc. Fort Lee, NJ. Butter oil brand name NZ imported from New Zealand Dairy Board, Wellington, New Zealand was obtained from the local market, Cairo, Egypt. Commercial fine grade sodium chloride (NaCl) was obtained from EL-Nasr Salines Co., Alexandria, Egypt. Calcium chloride was obtained from EL-Nasr for chemicals and pharmaceutical industries, Cairo, Egypt. Commercial emulsifying salt S_9 special were obtained from JOHA BK Ladenburg corp., GmbH, Ladenburg, Germany. Nisin used as preservative in this study was produced by Zhejiang silver elephant Bio – Engineering Co., China, and was obtained from Amson international trading, Giza – Egypt.

Ras cheese blocks were cut into small portions suitable to be fed through the inlet of a shredding machine (Braun mincer, Germany). Shredded cheese was milled in milling machine, (National, Japan). Suitable amount of Ras cheese, skim milk powder, butter, NaCl, nisin, stabilizer mixture and emulsifying salt were added consecutively in a laboratory style–processing Kettle locally made in Egypt. Specifications of the cooking machine were mentioned by Awad (1996). The ingredients were mixed for about 1 min before processing. Control treatment was adjusted to have the same composition without adding stabilizer. The mixture was cooked for 10 min at 85 – 90 °C using indirect steam at pressure of 1.5 – 2.0 Kg/cm^2. The melted processed cheese sauce was purred into wide mouth glass jars (150 g) and capped tightly after filling. The resultant cheese sauce was cooled at room temperature and then analyzed when fresh and monthly up to 3 months during storage either in refrigerator (5 ± 2°C) or at room temperature (25 ± 2°C).

Table (1): Formulations of different processed cheese sauces manufactured using corn starch and sodium alginate or guar gum as thickening agents (kg/ 100 kg).

Ingredients	Formulas*						
	Control	CN- SA			CN- GG		
		1 : 1	2 : 1	1 : 2	1 : 1	2 : 1	1 : 2
Ras cheese	28.30	23.5	22.25	24.19	23.5	22.25	24.19
Butter fat	1.50	3.00	3.50	3.00	3.00	3.50	3.00
Corn starch	-	1.50	2.00	1.00	1.50	2.00	1.00
Sodium alginate	-	0.25	0.16	0.33	-	-	-
Guar gum	-	-	-	-	0.25	0.16	0.33
Skim milk powder	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Emulsifying salt	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Nisin	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Water	67.17	68.72	69.06	68.45	68.72	69.06	68.45
Total	100	100	100	100	100	100	100

*** CN : Corn starch SA : Sodium alginate GG : Guar gum**

Cheese sauce samples were tested for Moisture, Fat, salt, ash contents as mentioned by AOAC (2005). Total nitrogen (TN) and soluble nitrogen (SN) contents were measured using the semi micro-Kjeldal method according to the method described by Ling (1963). Total volatile fatty acids (TVFA) value was determined according to the method described by KosiKowski (1982) and values were expressed as ml of 0.1 N NaOH / 100 g cheese sauce. The pH Values were measured using the electric HANNA instrument pH 213 microprocessor pH meters by inserting the pH combined

glass electrode (Electric Instruments limited) directly in the sample. Values of pH were reported to nearest 0.01 units

Oil separation index (OSI) of processed cheese sauce was determined as described by Thomas (1973). It could be summarized as follows :

A cork borer was used to obtain cylindrical samples of processed cheese sauce approximately 17.0 mm X 17.0 mm. The sample was pressed gently between Whatman filter paper No. 41 and incubated at 45°C for two hours. The diameter of the spread oil & water was measured in mm and used as an oil and water separation index as follows :

Oil and water separation index = (A – B) / B X 100

A : Diameter of spread after heating.

B : Diameter of spread before heating.

Viscosity of processed cheese sauce samples was measured according to Viturawong*et al* (2008) using a coaxial rotational viscometer, Brookfield Engineering labs DV- III ultra rheometer, at shear rates ranging from 12.411 to 74.467 sec^{-1} . The measuring device spindle (HA-07) was used with a sample volume of 110 g per run. The apparent viscosity was recorded at all shear rates.

Sensory evaluation was carried out according to the Scheme of Meyer (1973). The evaluation was done by regular scoring panel of members in the Food Science Department, Faculty of Agriculture, Ain Shams University and Dairy department, Food Technology Research Institute, Agriculture Research Center.

Statistical analysis was performed according to **SAS Institute (2006)** using General Linear Model (GLM). Duncan's multiple rang was used to separate among means of three replicates of samples.

RESULTS AND DISCUSSIONS

Chemical composition (%) of processed cheese sauces manufactured using different combinations of corn starch (CS) and sodium alginate (SA) or guar gum (GG) in different ratios are shown in Table (2). Among sauce treatments with stabilizers mixtures the total solid contents in the end products ranged from 25.89 % in sauce treatment with corn starch + guar gum 2 : 1 to 24.72 % in sauce treatment with corn starch + sodium alginate 2 : 1. Control treatment contained slightly higher total solid contents being 25.91 %. Fat / dry matter content ranged from 41.09 % in sauce treatment with corn starch + guar gum 1: 1 to 40.36 % in sauce treatment of corn starch + sodium alginate 1: 1. As can be seen from the data, total solid and fat / dry matter contents were of narrower range, and both of them were adjusted in the base recipes to be 25 % and 40 %, respectively, in all treatments including the control. These slight differences could be due to the differences in weight of raw materials used to formulate the blends of cheese sauces.

Table (2):Chemical composition (%) of processed cheese sauces manufactured using different combinations of corn starch and sodium alginate or guar gum as thickening agents.

Treatments*		Total solids	F/DM	Total nitrogen	Ash	Salt/moisture
Control		25.91	40.85	1.58	3.23	2.17
	1:1	25.66	40.36	1.52	2.91	1.28
CN- SA	2:1	24.72	40.66	1.47	2.91	1.20
	1:2	24.82	40.54	1.49	3.03	1.27
	1:1	25.45	41.09	1.50	2.93	1.24
CN- GG	2:1	25.89	40.85	1.55	2.97	1.27
	1:2	25.53	40.84	1.51	2.91	1.22

***See Table (1)**

Table (2) shows also the total nitrogen (TN), ash, salt and salt / moisture values of processed cheese sauce samples produced with thickening mixture of corn starch and sodium alginate (SA) or guar gum (GG) in different ratios. The data indicated that the control treatment without thickening material has the highest values of all measured characters. Control treatment present contained 1.58, 3.23 and 2.17 % of TN, ash, salt / moisture, respectively. On the other hand, all examined characters for all treatments with added thickening mixtures showed lower values than that of control. The values of TN ranged between 1.55 and 1.47 among all cheese sauce samples with stabilizer mixtures, while ash values ranged from 3.03 to 2.91 and salt / moisture values were in the range of 1.28 to 1.20 %. The higher values of TN, ash and salt / moisture were observed in control treatment than that of other treatments with stabilizers, mainly due to the higher Ras cheese content (see Table, 1). Adding higher Ras cheese percentage in control treatment increased the values of TN, ash and salt / moisture in final product since it is the main source of these contents. On the other hand, the variations among sauces manufactured with added corn starch & stabilizers in TN, ash and salt / moisture were slight and all values were lower than the control, due to the lower Ras cheese contents in formulated recipes. The slight differences among cheese sauce samples with added stabilizer mixtures of corn starch and sodium alginate (SA) or guar gum (GG) could be due to the slight differences in its contents of Ras cheese base.

The values of pH in processed cheese sauces made using different mixtures of corn starch and sodium alginate or guar gum when fresh and during storage up to 3 months in the refrigerator or at room temperature are presented in Table (3). The values of fresh samples were 5.78, 5.82 , 5.82, 5.83, 5.82, 5.85 and 5.84 for the control, processed cheese sauces with corn starch + sodium alginate 1 : 1, 2 : 1, 1 : 2 and processed cheese sauces with corn starch + guar gum 1 : 1, 2 : 1 and 1 : 2 respectively. The obtained data

showed that the control treatment possessed lower pH value than that of all other fresh treatments with thickening agents. This is due to the higher ratio of Ras cheese in control treatment which has lower pH value. Among fresh treatments with stabilizing mixtures, there were a slight and non significant differences in pH value, and the average of all treatments was 5.82.

During storage of cheese sauce samples up to 3 months the pH values decreased in all treatments including the control. The changes were more pronounced in samples stored at room temperature. These changes in pH values of cheese sauces during storage could be due to the changes in SN and hydrolysis of polymerized phosphate present in emulsifying salts and their interaction with proteins. The obtained data were in agreement with the finding of **Awad*et al*** **(2003)**.

Table (3): The pH values of processed cheese sauce manufactured using different combinations of corn starch and sodium alginate or guar gum as thickening agents when fresh and during storage.

Treatments*		Fresh	1 Month		3 Months	
			5 ºC	25 ºC	5 ºC	25 ºC
Control		5.78^{Aa}	5.77^{Ba}	5.75^{Bab}	5.67^{Bbc}	5.60^{Ac}
CN- SA	1:1	5.82^{Aa}	5.79^{Aa}	5.75^{Aab}	5.67^{Abc}	5.63^{Ac}
	2:1	5.82^{Aa}	5.8^{Aa}	5.75^{Aa}	5.66^{Ab}	5.63^{Ab}
	1:2	5.83^{Aa}	5.82^{Aa}	5.76^{Aab}	5.65^{Ac}	5.62^{Abc}
CN- GG	1:1	5.82^{Aa}	5.81^{Aa}	5.75^{Aa}	5.66^{Ab}	5.62^{Ab}
	2:1	5.85^{Aa}	5.83^{Aa}	5.75^{Aa}	5.65^{Ab}	5.59^{Ab}
	1:2	5.84^{Aa}	5.82^{Aa}	5.76^{Aa}	5.67^{Ab}	5.62^{Ab}

***See Table (1)**

Means with the same letter among treatments in the same storage period are not significantly different.

Means with the same letter in the same treatment during storage periods are not significantly different.

Soluble nitrogen content of processed cheese sauces as affected by adding mixtures of corn starch and sodium alginate or guar gum in different ratios are shown in Table (4). The data in the table stated that the use of the mixtures of corn starch and sodium alginate or guar gum caused a slight decrease in SN content in the resultant cheese sauces. Soluble nitrogen content ranged from 0.782 to 0.735 % for corn starch + guar gum 1 : 2 and corn starch + sodium alginate 2 : 1 treated sauces respectively, meanwhile soluble nitrogen content was 0.889 % for the control sauce made with no added thickening agents. It can be seen that, the control sauce was the highest when compared with all other treated sauces and sauce with sodium alginate 2 :1 was the lowest. The higher value of SN in control treatment was related to the higher amount of Ras cheese used as cheese base when formulating the blends of the resulted processed cheese sauces.

During storage period, soluble nitrogen content after 1 month slightly increased in all treatments even the control. This means that the protein was

solubilized in cheese sauces during storage period. Protein solubilization of all treatments were higher for the sauces stored at room temperature more than sauces stored in the refrigerator. Extending the storage period for 3 months caused higher degree of hydrolysis directed to higher SN content. The increase in solubilization were more obvious especially in samples stored at room temperature more than that stored in the refrigerator. These also could be due to changes of the pH values and the enzymatic activity of that resistant proteinases present in product. These results agree with that reported by Tamime*et al* (1990) andAwad *et al* (2003).

Table (4):Soluble nitrogen content (%) of processed cheese sauce manufactured using different combinations of corn starch and sodium alginate or guar gum as thickening agents when fresh and during storage.

Treatments*		Fresh	1 Month		3 Months	
			5 ºC	25 ºC	5 ºC	25 ºC
Control		0.889^{Ac}	0.903^{Ac}	1.011^{Ab}	1.067^{Aab}	1.127^{Aa}
CN- SA	1:1	0.743^{Bc}	0.809^{ABc}	0.920^{ABb}	0.924^{CBb}	1.080^{Aa}
	2:1	0.735^{Bc}	0.819^{Acb}	0.846^{BCb}	0.894^{CBb}	1.093^{Aa}
	1:2	0.775^{Bb}	0.803^{Bb}	0.809^{Cb}	0.833^{Cb}	1.033^{ABa}
CN- GG	1:1	0.748^{Bc}	0.840^{ABbc}	0.860^{BCb}	0.892^{CBab}	0.977^{Ba}
	2:1	0.766^{Bc}	0.818^{ABcb}	0.860^{BCcb}	0.905^{CBb}	1.062^{Aa}
	1:2	0.782^{Bc}	0.869^{ABc}	0.975^{Ab}	0.979^{Cb}	1.094^{Aa}

***See Table (1)**

Means with the same letter among treatments in the same storage period are not significantly different.
Means with the same letter in the same treatment during storage periods are not significantly different.

Total volatile fatty acids of processed cheese sauces as affected by using mixtures of corn starch and sodium alginate or guar gum are shown in Table (5). The values of TVFA were 16.90, 15.23, 16.47, 14.98, 16.76, 15.89 and 15.22 as ml NaOH 0.1 N / 100 g cheese sauce of control and treatments with corn starch + sodium alginate or corn starch + guar gum in ratios 1 : 1, 2 : 1, 1 : 2, respectively. These data proved that all treatments with thickening mixtures possessed lower TVFA values than the control treatment with no added stabilizer mixtures. The variations in TVFA values among sauce treatments with stabilizing mixtures either corn starch + sodium alginate or corn starch + guar gum were no significant. The differences between control and treatments with stabilizers in TVFA values could be related to the components used to formulate the base blends. The higher ratio of Ras cheese in the base blend caused higher value of TVFA in control treatment, these results agree with those of EL- Neshawy*et al* (1987) and Hassan &Abd El-Gawad (2000).

Storage of cheese sauce samples up to 3 months caused an increase of TVFA values in all treatments including the control. The changes

in TVFA were more pronounced in the control treatment than that of other treatments. On the other hand, cheese sauce samples stored at room temperature exhibited higher TVFA values than that stored in the refrigerator. Changes in TVFA values of stored samples could be attributed to the degradation and hydrolysis that occurred in fat and proteins of added raw materials. These degradation and hydrolysis are affected by moisture content and storage period & temperature. These results are in agreement with Othman *et al* (2005).

Table (5) :Total volatile fatty acids values (TVFA☼) of processed cheese sauce manufactured using different combinations of corn starch and sodium alginate or guar gum as thickening agents when fresh and during storage.

Treatments*		Fresh	1 Month		3 Months	
			5 ºC	25 ºC	5 ºC	25 ºC
Control		16.90^{Ac}	17.80^{Ac}	19.60^{Bc}	25.70^{Ab}	30.60^{Aa}
CN- SA	1:1	15.23^{Ac}	15.82^{Bc}	16.44^{CDc}	20.27^{Cb}	24.64^{Da}
	2:1	16.47^{Ac}	17.14^{ABc}	18.10^{CBc}	22.64^{Bb}	27.27^{Ba}
	1:2	14.98^{Ac}	15.60^{ABc}	16.55^{Ab}	21.62^{ABa}	24.08^{Ec}
CN- GG	1:1	16.76^{Ac}	17.26^{ABc}	18.15^{CBc}	20.62^{Cb}	26.67^{CBa}
	2:1	15.89^{Ac}	16.35^{ABc}	17.42^{CDc}	19.64^{Cb}	25.20^{CDa}
	1:2	15.22^{Aa}	15.43^{Bb}	16.65^{Dc}	19.08^{Cc}	26.76^{CBc}

***See Table (1)☼ ml NaOH 0.1 N / 100 g cheese**

Means with the same letter among treatments in the same storage period are not significantly different.

Means with the same letter in the same treatment during storage period are not significantly different.

Table (6) illustrates the changes in oil separation index (OSI) of processed cheese sauces with different combinations of corn starch and sodium alginate or guar gum. From the table, it is clear that addition of corn starch and sodium alginate or guar gum mixtures in processed cheese sauces formulas had different effects on oil separation index values of the resultant processed cheese sauces with sodium alginate or even with guar gum. Oil separation index values were 26.15, 22.08, 19.24, 23.38 , 20.00 , 22.58 and 19.20 for the resultant control processed cheese sauce, processed cheese sauces of corn starch + sodium alginate 1 : 1, 2 : 1, 1 : 2 and processed cheese sauces of corn starch + guar gum 1 : 1, 2 : 1 and 1 : 2 respectively. Syrbe*et al* (1998) mentioned that, covalent cross linked protein–hydrocolloid conjugates fulfill the conflicting requirements for an adsorbing hydrophobic terminal at the oil–water interface and a bulky hydrophilic end for efficient polymeric stabilization, protein – hydrocolloid conjugates include strong electrostatic complexes of protein and hydrocolloids. The differences among these treatments in oil separation index could be also related to the ability of each mixture to make a stable phase and stable emulsion and reject the fat inside (Heyman*et al,*2010).

When the storage period increased oil separation index increased in the control sauce, in spite of it decreased in all other treated sauces made by using sodium alginate or even guar gum when added in different ratios to the corn starch in the base blends. The trend to the increase in the control sauce or to the decrease in the other treated sauces were more observed at the samples stored at room temperature. The differences in oil separation index changes could be related to the state of emulsion and emulsification capacity in final products. Control processed cheese sauce made without adding stabilizing agents exhibit a weak emulsion and less emulsification capacity. A better emulsion and a good emulsification capacity would be produced in sauce treatments with stabilizing agents which may help in lowering the oil separation from sauce products.

Table(6):Oil separation index of processed cheese sauce manufactured using different combinations of corn starch and sodium alginate or guar gum as thickening agents when fresh and during storage.

Treatments*		Fresh	1 Month		3 Months	
			5 ºC	25 ºC	5 ºC	25 ºC
Control		26.15^{Ae}	27.66^{Ad}	29.50^{Ac}	38.23^{Ab}	44.30^{Aa}
CN- SA	1:1	22.08^{Ba}	20.20^{Ba}	18.50^{Bb}	15.89^{Bc}	11.34^{Bd}
	2:1	19.24^{Ca}	15.93^{Db}	13.25^{Ec}	10.60^{Cd}	7.97^{Ce}
	1:2	23.38^{Ba}	20.40^{Bb}	17.14^{CBc}	14.28^{Bd}	10.32^{Be}
CN- GG	1:1	20.00^{Ca}	18.28^{Ca}	14.60^{EDb}	11.11^{Cc}	8.33^{Cd}
	2:1	22.58^{Ba}	16.79^{CDb}	16.00^{CDb}	15.38^{Bb}	9.70^{CBc}
	1:2	19.20^{Ca}	16.31^{Db}	16.15^{CDb}	14.97^{Bb}	10.35^{Bc}

***See Table (1)**

Means with the same letter among treatments in the same storage period are not significantly different.
Means with the same letter in the same treatment during storage periods are not significantly different.

Viscosity values of processed cheese sauces manufactured using different mixtures of corn starch and sodium alginate or guar gum when fresh and after 3 months of storage are illustrated in Fig. (1). The data showed that among all cheese sauce treatments including the control, the viscosity values decreased with increasing the shear rate which represents a pseudoplastic material. Among treatments with thickening mixtures, the results stated that incorporation of corn starch & sodium alginate mixtures in the stabilizing system produced cheese sauce with highest viscosity values than that of guar gum. It can be seen that the viscosity values at shear rate 49.644 sec^{-1} were 2000, 2350 and 2500 cP in sauce samples with stabilizing mixtures of corn starch and sodium alginate in ratios of 1 : 1, 2 : 1 and 1 : 2 respectively. The corresponding viscosity values of sauce samples with mixtures of corn starch & guar gum in the same ratios were 1600, 1650 and 1100 cP in the same order.

f1

Control treatment present the lowest and significantly different viscosity value compared to all other treatments at any shear rate. The higher viscosity values in cheese sauce samples with stabilizing mixtures than that of control are mainly due to the presence of thickening materials in the base formulas. It is well known that the stabilizing agents reduce the free water in the matrix due changing it to bound water which increases the viscosity of the phase. Heyman*et al* (2010) mentioned that the presence of hydrocolloids introduce a marked increase in viscosity. The differences among treatments with different stabilizing mixture could be due to the difference in the ability of each stabilizer to bind water.

Viscosity values at different shear rates of stored cheese sauces samples after 3 months either at 5 ºC or at 25 ºC are also illustrated in Fig. (1). Sauces samples storage had affected their viscosity values and therefore their flow behaviour. Control treatment showed lower viscosity values i.e. thinner body & texture, by extending the storage period & temperature. It is clear that, storage also affected the degradation that happened in add thickening agents and affected also the protein hydrolysis. Viscosity values of treatments with added corn starch + sodium alginate were affected also by the storage temperature being lower when stored at lower temperature (5 ± 2 ºC). Nevertheless, the values being higher when stored at higher temperature (25 ± 2 ºC). The changes in viscosity values of these stored samples could be attributed to the changes in cheese sauce protein matrix and the degree & efficiency of holding water by stabilizing system. Processed cheese sauce treatments with stabilizing mixtures of corn starch + guar gum exhibited different flow behaviour as the viscosity values increased in all stored samples being highest when stored at room temperature (Heyman *et al,* 2010). This different trend could be also related to a different nature and behaviour of guar gum than that of sodium alginate in binding water. Cheese sauce treatments with a thickening mixtures of corn starch + sodium alginate 1 : 2 had the highest viscosity among sodium alginate group, while that with thickening mixtures of corn starch + guar gum, 2 : 1 possessed the highest viscosity among all cheese sauce treatments (Achayuthakan and Suphantharika, 2008)

Sensory quality attributes of processed cheese sauces with different stabilizing mixtures of corn starch and sodium alginate or guar gum are shown in Table (7). Control treatment with no thickening agents scored the lowest points especially in body & texture parameter and was significantly different than that of all other treatments with stabilizing system. This is confirming that cheese sauce samples should contain suitable stabilizing agents (McClements, 2006). Cheese sauce samples of stabilizing mixtures containing guar gum exhibited higher outer appearance scores than that containing sodium alginate. This could be explained why the treatments of guar gum appeared more bright & more shiny than that of sodium alginate. The inner appearance which expressed by the body & texture of cheese sauce showed no differences among all treatments with stabilizing systems. The aroma &flavour of cheese sauces were more preferable in treatments containing guar gum than that of sodium alginate. Total scores were 84.5, 92.5, 93.5, 92.5, 94.0, 96.5 and 93.5 for the control sauce, sauces of corn

starch + sodium alginate 1 : 1, 2 : 1, 1 : 2 and sauces of corn starch + guar gum 1 : 1, 2 : 1 and 1 : 2 respectively. These data stated that the overall acceptance of processed cheese sauce treatments with stabilizing mixtures containing guar gum were mostly preferred than that with mixtures containing sodium alginate and all samples were highly preferred than the control with no added stabilizing agents. Out of all treatments with thickening mixtures that consists of 2 : 1 either corn starch + sodium alginate or + guar gum scored the best.

During storage the score of all stored samples was gradually decreased up to 3 months at both degrees of storage (5 ± 2 ºC) or (25 ± 2 ºC). All sensory quality parameters scored lower points and all cheese sauce samples became less preferable to panelists after 3 months of storage especially at higher temperature (25 ºC). Treatments with thickening mixtures containing guar gum continued to be the most preferable than other treatments with thickening mixtures containing sodium alginate (Ferry *et al,* 2006).

Table (7): Sensory evaluation of processed cheese sauce manufactured using different combinations of corn starch and sodium alginate or guar gum as thickening agents when fresh and during storage.

Storage		Character assessed	Treatments*						
Period	Temp.		Control	CN- SA			CN- GG		
				1 : 1	2 : 1	1 : 2	1 : 1	2 : 1	1 : 2
Fresh		O. A. (20)	17.5^{Ba}	18^{ABa}	18^{ABa}	17^{Ba}	18.5^{ABa}	19^{Aa}	18.5^{ABa}
		B&T (40)	30^{Ea}	37.5^{Aa}	38.5^{Aa}	38^{Aa}	37.5^{Aa}	38.5^{Aa}	37^{Aa}
		A&F (40)	37^{Ca}	37^{Ba}	37^{Ba}	37.5^{ABa}	38^{ABa}	39^{Aa}	38^{ABa}
		T (100)	**84.5^{Da}**	**92.5^{Aa}**	**93.5^{Aa}**	**92.5^{Aa}**	**94^{Aa}**	**96.5^{Aa}**	**93.5^{Aa}**
1 Month	5ºC	O. A. (20)	17^{Ca}	17.5^{ABab}	17.5^{ABab}	16.5^{Bab}	18^{ABa}	18.5^{Aab}	18^{ABa}
		B&T (40)	29^{Dab}	37^{Aa}	38^{Aab}	37.5^{Aab}	37^{Aa}	38^{Aa}	36.5^{Aa}
		A&F (40)	36.5^{Ca}	37^{BCa}	36.5^{BCab}	36^{Cab}	37.5^{ABCab}	39^{Aa}	38^{ABa}
		T (100)	**82.5^{Dab}**	**91.5^{ABa}**	**92^{ABabc}**	**90^{Babc}**	**92.5^{ABa}**	**95.5^{Aa}**	**92.5^{ABa}**
	25ºC	O. A. (20)	16^{Cb}	17^{ABabc}	17^{ABabc}	16^{Bab}	17.5^{ABab}	18^{Aab}	17.5^{ABa}
		B&T (40)	28^{Db}	36^{ABab}	37^{ABbc}	36.5^{Bb}	36.5^{ABab}	37.5^{Aab}	36^{ABa}
		A&F (40)	36^{Cab}	36^{BCa}	36^{BCab}	35^{Cb}	37^{ABab}	38.5^{Aab}	37^{ABab}
		T (100)	**80^{Ac}**	**89^{ABab}**	**90^{ABabc}**	**87.5^{Bbc}**	**91^{ABab}**	**94^{Aab}**	**90.5^{ABab}**
3 Months	5ºC	O. A. (20)	15^{Bc}	16^{ABCbc}	16^{ABCbc}	15.5^{BCab}	17^{ABab}	17.5^{Aab}	17^{ABab}
		B&T (40)	25^{Dc}	35^{Bbc}	36^{Bc}	35.5^{Bb}	36^{ABab}	37^{Aab}	35.5^{ABab}
		A&F (40)	35^{Cb}	34^{CDb}	35^{BCbc}	33^{Dc}	36.5^{ABa}	38^{Aab}	36^{Bbc}
		T (100)	**75^{Dd}**	**85^{BCbc}**	**87^{BCc}**	**84^{Cc}**	**89.5^{ABab}**	**92.5^{Aab}**	**88.5^{ABCab}**
	25ºC	O. A. (20)	14^{Bd}	15.5^{ABCc}	15.5^{ABCc}	15^{BCb}	16^{ABb}	17^{ABCb}	16^{ABb}
		B&T (40)	22^{Dd}	34^{Dc}	35^{Aa}	35^{ABa}	35^{CDb}	36^{BCb}	34^{Db}
		A&F (40)	33^{Cc}	33^{Deb}	34^{CDc}	32^{Ec}	36^{AB}	37^{Ab}	35^{BCc}
		T (100)	**69^{De}**	**82.5^{Bc}**	**84.5^{ABbc}**	**82^{ABc}**	**87^{ABb}**	**90^{Ab}**	**85^{ABb}**

***See Table (1)**

Outer appearance, B&T: Body& texture, A&F: Aroma &flavour, T :Total score

A, B, C: Means with the same letter among treatments in the same storage period are not significantly different.

a, b, c: Means with the same letter in the same treatment during storage period are not significantly different.

CONCLUSION

Incorporation of corn starch and sodium alginate or guar gum as stabilizing mixtures in the formulated blends produced processed cheese sauces as an end products with excellent mouthfeel and flow ability. The mixture of corn starch and guar gum were much better than the others. Therefore, it could be recommended upon the previous results that, to produce processed cheese sauces with high quality and acceptability for consumers as an appetizer it has to contain a stabilizing mixture that consists of corn starch + guar gum in ratio of 2 : 1.

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تأثير مخاليط من النشا والمثبتات الأخرى كعوامل مغلظة للقوام فى صناعة مشهيات الجبن المطبوخ

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تم إجراء هذه الدراسة لمعرفة ما لمخاليط المثبتات من تأثير على خواص مشهيات الجبن المطبوخ حيث تم إستخدام مخاليط مكونة من نشا الذرة مع صمغ الجوار أو الجينات الصوديوم بنسب ١ : ١ , ١ : ٢ , ٢ : ١ لكل منهما وتم الحصول على النتائج التالية : قيم النيتروجين الكلى ونسبة الملح / الرطوبة كانت الأعلى فى عينة المقارنة عن كل العينات الأخرى التى تم تصنيعها بإضافة مخاليط المثبتات. قيم درجة الـ pH كانت ٥.٧٨– ٥.٨٢– ٥.٨٢ – ٥.٨٣ – ٥.٨٢ – ٥.٨٥ – ٥.٨٤ للعينة المقارنة وعينات نشا الذرة والجينات الصوديوم بنسبة ١ : ١ , ٢ : ١ , ١ : ٢ وأيضاً عينات نشا الذرة وصمغ الجوار بنفس النسب على الترتيب. الأحماض الدهنية الطيارة كانت عند أعلى قيمة لها فى المعاملة المقارنة وعند أقل قيمة فى المعاملة المصنعة بإضافة نشا الذرة والجينات الصوديوم بنسبة ١ : ٢ مقارنة بباقى المعاملات. إضافة الجينات الصوديوم وصمغ الجوار أدت إلى أن تكون القيم للعينات المصنعة بإستخدام مخاليط المثبتات مختلفة عن العينة المقارنة من حيث خواص إنفصال الدهن حيث إنخفض إنفصال الدهن فى كل العينات ذات المثبتات. بالنسبة لقيم اللزوجة أوضحت المعاملات أن تلك المصنعة بإضافة الجينات الصوديوم كان لها قيم أعلى عن تلك المصنعة بإضافة صمغ الجوار وكانت أقل القيم للعينة المقارنة بدون إضافة أى مثبتات. الخواص الحسية أوضحت أن أقل قيمة من بين كل العينات كانت للعينة المقارنة لأنها كانت الأقل من حيث خواص القوام والتركيب وكانت قيم خواص الطعم والنكهة فى عينات نشا الذرة مع صمغ الجوار هى الأعلى مقارنة بعينات نشا الذرة مع الجينات الصوديوم وظلت عينات نشا الذرة مع صمغ الجوار وخاصة النسبة ٢ : ١ هى الأفضل حتى نهاية فترة التخزين سواء عند التخزين على درجة حرارة الثلاجة أو على درجة حرارة الغرفة.