A Study on the Factors Influencing the Salting of Kaschkaval Cheese

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Introduction

The content of salt in cheese plays a great role in the formation of the desirable properties and quality of the cheese. The salt participates in forming the taste of the cheese It has an effect on numerous chemical and physical properties. The intensity of ripening of the cheese also depends on the salt content to a certain extent. Turner and Thomas (1980) and Thomas and Pearce (1981) found strong correlations between residual lastose concentration and salt in moisture concentration (S/M), between cheese pH and S/M concentration and between residual lactose concentrattion and pH.

In one month old Cheddar cheese containing 4 % S/M, approximately 5 % of the α_{s1} - casein and 50 % of the B - casein remained unhydrolysed. The corresponding figures for 6 % S/M were 30 % and 80 %, while at 8 % S/M, 60 % of α_{s1} - casein and 95 % of the B - casein was unhydrolysed (Thomas and Pearce, 1981). Turner and Thomas (1980) reported that lactose utilization and L - lactic acid production by starter bacteria in Cheddar cheese were markedly affected by variation in S/M level between 4 and 6 %. Lelievre and Gilles (1982) came to the conclusion that in Cheddar cheese, grades increased as S/M decreased from 6 % to 4 %. Turner and Thomas (1980) reported that in Cheddar cheese with high S/M levels (about 6 %) starter metabolism virtually stoped so that lactose concentration was still high after several weeks of storage. Godinho and Fox (1981) found that the concentration of FFA in Blue cheese increased rapidly in cheese with optimal salt concentration (4 - 6 %). Lipolysis was delayed by higher salt concentration.

Numerous investigations have shown that there is an optimal salt content for certain cheeses. Any deviation of the amount of salt from the optimal limits regularly causes various undesirable changes in the cheese. The optimal amount of salt in the cheese can vary only within narrow limits. This ranges in Gouda cheese from 2.32 to 2.55 % of salt (Harsev Singh and Brave, 1979), or $\geq$ 3 % in Feta cheese (Hansen, 1980). Turner and Thomas (1980), Thomas and Pearce (1981) and Lelievre and Gilles (1982) mentioned that the ranges of S/M in Cheddar cheese must be within the values 4 - 6 %. This shows that the salting of cheese is a very important technological operation.

The salting of the cheese in succesfully done by control and adjustment of the operation. However, succesful control and adjustment of salting are possible only with a knowledge fo the process of salting itself and with a suitable method of control. Numerous investigations on salting of cheese have paid only little attention to this problem, so that at present there is no method of control which is sufficiently accurate and which is also suitable to broad practice. The basic reason why such a method is not yet available, lies in the fact that salting of the cheese is a complex physico - chemical process. A whole range of physical and chemical changes take place when cheese is salted. In addition, many factors affect the salting of cheese, i.e., the size and shape of the cheese, the duration of salting, the concentration and acidity of the brine, the moisture content of the cheese and the body and structure of the cheese. Accordingly it is obvious that the control and adjustment of the salting process must be based on the control of certain factors and changes in the cheese as well as on a knowledge of the principle on which they act. In order to work out a single system of control which will take all essential factors into consideration, it is important to investigate in advance

the effect of certain factors in the process of salting. It is essential to determine the basic law of action of certain factors. Although there are very scant experimental data on the effect of the size and shape of the cheese on the salting, and particularly on the duration of salting, it is obvious that these fall into the group of essential factors in salting which must be carefully watched in the control of the process.

The aim of this work was to establish to what extent a change in the size and form of the cheese affects the amount of absorbed salt in Kaschkaval cheese, what is the effects of a change in the surface area, volume and relative surface area on the amount of absorbed salt, whether a change in the percentage of absorbed salt, under the influence of variation of these factors, moves according to a certain law, and whether there are any interrelations between these factors. What possibility exists for controlling the salting with regard to the effect of the size and form of the cheese on the amount of absorbed salt.

Materials and Methods

Kaschkaval cheese was made by the technological process which is known in the literature as the Italian method as described by Safwat (1954). The cheese was made from cow's milk.

Besides the standard size and form of Kaschkaval cheese, it was also made in other shapes and sizes, for experimental purposes (Table 1), so that we could investigate in details the effect of the changes in the size and form on the salting.

The cheese was salted in 20 % brine solution. During the salting the cheese was saturated in the brine and it was pressed down with a wooden frame. Every 5 - 6 hours the brine was mixed throughly and checked its concentration. The salting was done at temperature from 10° to 13°C. A check of the percentage of absorbed salt was made every 24 hours for 5 days. The salt content was determined as previously desribed by Hassan (1971).

The data were subjected to the analysis of regression and F test was used to detect the statistical significance according to Düz güneş (1963).

Table 1 : Variants, Forms and Sizes of examined Cheeses

Variants	Dimensions in Cm.			
	Diameter	Length	Height	Width
I	10	—	6	—
II	10	—	8	—
III	10	—	10	—
IV	10	—	12	—
V	10	—	20	—
VI	10	—	30	—
VII	20	—	6	—
VIII	20	—	8	—
IX	20	—	10	—
X	20	—	12	—
XI	30	—	6	—
XII	30	—	8	—
XIII	30	—	10	—
XIV	30	—	12	—
XV	—	12	6	9
XVI	—	18	9	9
XVII	—	30	9	12

Results

Effect of the Change in Surface Area

The surface area of the cheese has an effect on the amount of absorbed salt. Hence, this factor is interesting for the control of salting. For the latter it is especially important to establish, to what degree and how the changes of surface areas affects the rate of absorbtion of salt, and whether it is possible to take the surface area of the cheese as an index of the size and form which can be used for the practical control of the salting.

In order to show the effect of a change in surface area on the rate of absorbtion of salt, all the test series have been arrenged according to the surface of the cheese, regardless of its chape and dimensions. These date are given in Table 2.

Table 2 : The Salt Content in Cheeses With Different Surfaces

Variants	Surface in Cm²	Percentage of absorbed salt in cheese during the salting, in hours				
		24	48	72	96	120
I	345	2.69	3.68	4.36	4.69	—
II	408	2.45	3.40	4.05	4.38	—
XV	468	2.71	3.73	4.43	4.77	—
III	471	2.33	3.21	3.85	4.18	—
IV	534	2.22	3.10	3.72	4.03	—
V	«85	2.05	2.87	3.46	3.76	—
XVI	810	2.13	2.96	3.51	3.82	—
VII	1005	2.05	2.92	3.52	3.85	—
VI	1099	1.94	2.67	3.29	3.67	—
VIII	1130	1.72	2.53	3.04	3.37	—
IX	1256	1.57	2.26	2.80	3.09	—
X	1382	1.48	2.20	2.64	2.85	—
XVII	1476	1.79	2.55	3.02	3.24	—
XI	1978	1.83	2.65	3.22	3.59	3.84
XII	2167	1.54	2.25	2.79	3.13	3.36
XIII	2355	1.30	1.94	2.44	2.77	3.01
XIV	2543	1.16	1.77	2.25	2.57	2.76

From the data in Table 2 it is clear that there is a general tendency for the percentage of absorbed salt to decrease with an increase in the surface area of the cheese. There is a conversely proportional ratio between the percentage of absorbed salt and the surface area of the cheese. This can be observed with the cheeses of all forms and with all durations of salting.

The decrease of series I, which had the smallest surface area (345 cm²) absorbed the highest percentage of salt, while the cheese of series XIV with the greatest surface area (2543 cm²) absorbed the lowest percentage of salt. However, the decrelse in the percentage of absorbed salt does not place uniformly. This is clear when we compare the intensity of the change in the percentage of salt with changes in the surface area of cheese with different dimensions and forms.

From the data presented in Table 2 we can observe that with an increase in the surface area of cheese, the percentage of absorbed salt drops rapidly at frist, and then slowly. The rate of the decrease in the percentage of absorbed salt is greater in cheese with a smaller surface area. This rate of decrease depends on numerous conditions. Thus cheese of various forms and sizes which have a different height or diameter, though they may have the same area, do not absorb the same percentage of salt. It can be concluded from this that the surface area of the cheese cannot be taken as the only index of the size and form of cheese for the control of salting.

Table 3 : Correlation Coefficients Between Percentage of Absorbed Salt and Surface (x_1), Volume (x_2) and Relative Surface Area (x_3) of the Cheese During Salting.

	Y_1 24 h.	Y_2 48 h.	Y_3 72 h.	Y_4 96 h.
x_1	—0.893*	—0.888*	—0.847*	—0.863*
x_2	—0.895*	—0.893*	—0.883*	—0.867*
x_3	0.984**	0.995**	0.921**	0.988**

The statistical analysis, Table 3, shows that during the salting of Kaschkaval cheese the cerrelation between the percentage of absorbed salt and surface area of the cheese was negative correlation. Correlation coefficient was $r = -0.893$, $r = -0.888$, $r = -0.863$ after 24, 48, 72 and 96 hours of salting. The correlation coefficient was significant ($P < 0.05$).

Tablo 4 : Linear regression between percentage of absorbed salt and surface of the cheese during salting.

Duration of saltin in hours	a	b	$\pm S_{XY}$	P	$X = a \pm b Y$
24	2.62	—0.00057	0.12	5 %	x = 2.62 - 0.00057 Y
48	3.59	—0.00071	0.15	5 %	x = 3.59 - 0.00071 Y
72	4.15	—0.00073	0.16	5 %	x = 4.15 - 0.00073 Y
96	4.58	—0.00079	0.17	5 %	x = 4.58 - 0.00079 Y

From Tablo 4 and Fig. 1, it can be observed that during the salting of Kaschkaval cheese the percentage of absorbed salt was in negative regression with the surface area of the cheese. The regression coefficient was significant. ($P < 0.05$).

Effect of the Change in Volume

Since in salting, the surface area of the cheese cannot be taken as a joint index for the size and form, it is necessary to see whether is possible to use the volume of the cheese for this reason. In order to show the effect of changes in cheese volume on the rate of salt absorbtion, we have arranged all the test series by the volume of the cheeses, regardless of their forms and dimensions. These date are given in Table 5.

From the data in Table 5, it is clear that there is a general tendency towards a fall in the pencentage of absorbed salt with an increase in the volume of the cheese. This fact is proved by the negative correlation, determined by the statistical analysis, Table 3. Correlation coefficients associated with the

Table 5 : Salt Content in Cheese With Different Volumes

Variants	Volume in Cm^3	Percentage of absorbed salt in in hours. 24	48	72	96	120
I	471	2.69	3.68	4.36	4.69	—
II	628	2.45	3.40	4.05	4.38	—
XV	648	2.71	3.73	4.43	4.77	—
III	785	2.33	3.21	3.85	4.18	—
IV	942	2.22	3.10	3.72	4.03	—
XVI	1458	2.13	2.96	3.51	3.82	—
V	1570	2.05	2.87	3.46	3.76	—
VII	1884	2.05	2.92	3.52	3.85	—
VI	2355	1.94	2.67	3.29	3.67	—
VIII	2512	1.72	2.53	3.04	3.37	—
IX	3140	1.57	2.26	2.80	3.09	—
XVII	3240	1.79	2.55	3.02	3.24	—
X	3768	1.48	2.20	2.64	2.85	—
XI	4239	1.83	2.65	3.22	3.59	3.84
XII	5652	1.54	2.25	2.79	3.13	3.36
XIII	7065	1.30	1.94	2.44	2.77	3.01
XIV	8478	1.16	1.77	2.25	2.57	2.76

Table 6 : Linear Regression Between Percentage of Absorbed Salt and Volume of the Cheese During Saltin

Duration of saltihg in hours	a	b	$\pm S_{XY}$	P	$X = a \pm b Y$
24	2.44	—0.00017	0.12	5 %	x = 2.44 - 0.00017 Y
48	3.37	—0.00022	0.15	5 %	x = 3.37 - 0.00022 Y
72	4.00	—0.00024	0.16	5 %	x = 4.00 - 0.00024 Y
96	4.32	—0.00024	0.17	5 %	x = 4.32 - 0.00024 Y

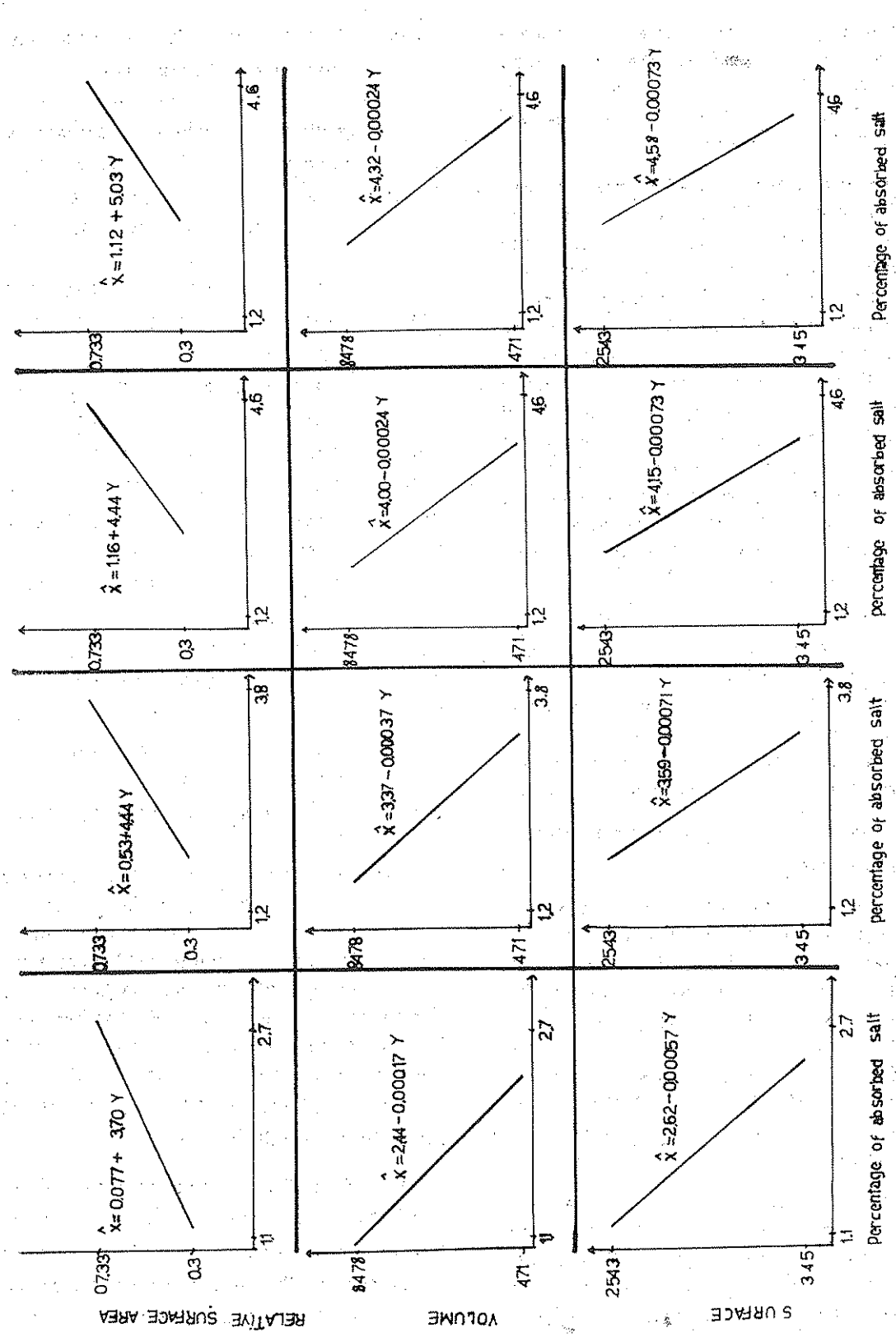

Fig. 1 : Regression between percentage of absorbed salt and the surface area, volume and the relative surface area of the cheese during salting.

relationship between the volume of the cheese and the percentage of absorbed salt during 24, 48, 72 and 96 hours of salting were r = —0.895, r = —0.893, r = —0.883 and rr = —0.867 respectively.

This was noticed for all duration of salting. However, the fall in the pencentage of absorbed salt with increase of volume was not uniform. With certain series, there were deviations, we see this, for example, when we compare series II and XV, V and VII, and IX and XVII and when we compare series XI and XII with series IX and X. These deviations shows that a fall in the percentige of absorbed salt with the increase in the volume of cheese is not the same with all forms and sizes of cheese. Hence, it may be concluded that the volume of the cheese cannot be taken as the only joint index for the size and form of cheese in the control of salting.

Table 6 and Fig. 1, shows the linear regression between volume of the cheese and percentage of absorbed salt during salting. From the results one can observe that during the salting of kaschkaval cheese the percentage of absorbed salt was in negative regression with the changes in the cheese volume.

Affects of the Changes in the Relative Surface Area

Considered separately, the surface area and volume of cheese are not convenient indixes for the size and form which can simply applied in the control of salting. Hence, Investigations were made on the effect of the relative surface area of the cheese (the area divided by the volume) on the dynamics of the absorbtion of salt. In Table 7 the percentage of absorbed salt in cheeses with different relative surface area are shown.

Form the data in Table 7 it is clear that the percentage of absorbed salt grows with an increase in the relative area of the cheese. It can be clearly seen that regardless of changes in the form and individual dimensions of cheese, the pencentage of absorbed salt always grows with an increase in the relative surface area.

Table 7 : Salt Content in Cheeses with Different Relative Surface areas

Variants	Relative surface area	Pencentage of absorbed salt in cheese during the salting in hours				
		24	48	72	96	120
XIV	0.300	1.16	1.77	2.25	2.57	2.76
XIII	0.333	1.30	1.94	2.44	2.77	3.01
X	0.367	1.18	2.20	3.64	2.85	—
XII	0.383	1.54	2.25	2.79	3.13	3.36
IX	0.400	1.57	2.26	2.80	3.09	—
VIII	0.450	1.72	2.53	3.04	3.37	—
XVII	0.456	1.79	2.55	3.02	3.24	—
XI	0.467	1.83	2.65	3.22	2.59	3.84
VI	0.467	1.94	2.67	3.29	3.67	—
V	0.500	2.05	2.87	3.46	3.76	—
VII	0.533	2.05	2.92	3.52	3.85	—
XVI	0.556	2.13	2.96	3.51	3.82	—
IV	0.567	2.22	3.10	3.72	4.03	—
III	0.600	2.33	3.21	3.85	4.18	—
II	0.650	2.45	3.40	4.05	4.38	—
XV	0.722	2.71	3.73	4.43	4.77	—
I	0.733	2.69	3.68	4.36	4.69	—

Table 3, shows the correlations between the relative surface area of the cheese and percentage of absorbed salt. The statistical analysis indicated that there were positive correlation between the relative surface area of the cheese and the percentage of absorbed salt. The correlation was highly significant ($P<0.01$) The correlation coefficient was r= 0.984, r= 0.995, r= 0.921 and r= 0.988 after 24, 48, 72 and 96 hours of salting.

Table 8 and Fig. 1, shows the linear regression between percentage of absorbed salt and relative surface area of kaschkavli cheese during salting. The results indicated that the percentage of absorbed salt was in positive regression with the changes in relative surface area. The regression coefficient was highly significant ($P<0.01$).

Table 8 : Linear Regression Between Percentage of Absorbed Salt and Relative Surface Area of the Cheese during Salting.

Duration of salting in hours	a	b	$\pm S_{xy}$	P	$X = a \pm bY$
24	0.077	+ 3.70	0.12	1 %	$x = 0.077 + 3.70\,Y$
48	0.53	+ 4.44	0.15	1 %	$x = 0.53 + 4.44\,Y$
72	1.16	+ 4.44	0.16	1 %	$x = 1.16 + 4.44\,Y$
96	1.12	+ 5.03	0.17	1 %	$x = 1.12 + 5.03\,Y$

Conclusions

On the basis of our investigations the following conclusions can be drawn :

1 — There is a great similarity between the effect of changes in the surface area and volume of cheese on the percentage of absorbed salt. With an increase in the surface area and volume of the cheese there is a decrease in the percentage of absorbed salt. This decrease of absorbed salt dose not take place uniformly. With smaller cheese, with increase in the surface area and volume, the decrease in the salt percentage is considerably greater than with bigger cheese.

2 — Every change of form and of individual dimensions is reflected differently on the percentage of absorbed salt, regardless of whether the cheese have the same surface area and volume. Cheeses which have different forms and different individual dimensions, do not absorb the same percentage of salt, although they have the same volume and surface area. That is why neither the surface area nor the volume can be taken as solely index of the size and form of cheese in the contril of salting.

3 — It has been established that the relative surface area of the cheese can be taken as a common index in the investigation of the effect of the size and form of cheese on the percentage of absorbed salt. With an increase in the relative area of the cheese, the percentage of absorbed salt grows.

Summary

The relationships between the cheese dimensions and the percentage of absorbed salt was studied in Kaschkaval cheese. The cheese was salted in 20 % brine solution. It was demonstrated that there is a great similarity between the effect of changes in the surface area and volume of the cheese on the percentage of absorbed salt. While, every change of form and of individual dimensions is reflected differently on the percentage of absorbed salt, regardless of whether the cheese have the same area and solume. Cheeses which have different forms and different individual dimension, do not absorb the same percentage of salt, although they have the same surface area and volumes.

It has been established that the relative surface area of the cheese can be taken as a common index in the investigation of the effect of the size and form of cheese on the percentage of absorbed salt.

ÖZET

Kaşar peynirinde, peynirin boyutları ile absorbe edilen tuz yüzdesi arasındaki ilişki arasındaki araştırılmış, peynir % 20'lik salamurada tuzlanmıştır. Peynirin yüzey alanındaki değişimlerle peynir hacmindeki değişimlerin, absorbe edilen tuz yüzdesi üzerindeki etkilerinin benzer olduğu sonucuna varılmıştır. Diğer taraftan, peynirin biçimindeki ve boyutlarındaki her değişim, absorbe edilen tuz yüzdesine farklı olarak yansımaktadır. Farklı biçim ve boyutlardaki peynirler, aynı alan ve hacme sahip olsalar dahi, aynı oranda tuz absorbe etmemektedirler.

Peynirin biçiminin ve büyüklüğünün absorbe edilen tuz yüzdesi üzerindeki etkisinin araştırıldığı bu çalışmada, peynirin nisbi yüzey alanının genel bir gösterge olarak alınabileceği ortaya konmuştur ki istatistiksel değerlendirmelerde bunun $p < 0.01$ düzeyinde önemli olduğunu kanıtlamaktadır.

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