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THE INFLUENCE OF HYPOTHERMIC SHOCKS AND ADDITIONS DURING PROCESSING, ON SOME YOGHURT FEATURES

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Abstract: *In this work there was searched the influence of some hypothermic shocks and compound admixtures, during yoghurt processing, on some yogurt features (pH, titratable acidity and curd aspect). The biological material used in this work was represented by cow milk, inoculated with a starter culture of thermophile lactic bacteria, including two different species: Streptococcus termophilus and Lactobacillus bulgaricus. The experiments during yoghurt processing have consisted in subjecting of samples to hypothermic shocks, on the one hand, and introducing of some admixtures (starch or gelatin), in certain proportions, on the other hand, to see the influence of these experiments on the evolution of pH, titratable acidity and quality characteristics of yoghur curd particles. The application of hypothermic shocks in the early period of thermostating has determined the decrease of fermentation activity of lactic bacteria (expressed by reduction of titratable acidity values) and has made the coagulation process of milk to be blocked. The later applied hypothermic shock, the lower effect on titratable acidity and coagulation process was. The addition of gelatine or starch during yoghurt processing has influenced, indirectly, the fermentation activity of lactic bacteria. The gelatin addition has led to the increase of titratable acidity values, comparing to blank. The addition of gelatine or starch has not rushed the milk coagulation during yoghurt processing. Compared to the control, in samples with admixtures the curd formation was slower, especially in those ones with starch addition.*

Keywords: *yoghurt, hypothermic shocks, titratable acidity, pH, starch, gelatin.*

1. Introduction

In order to avert food unbalances caused by various deficiency states, last time some nourishing substances are introduced within foods, being an efficient way to ensure an optimum healthy state of people (1, 2, 3).
The admixtures of active biological compounds within products poor in nutritional substances is the method to get fortifiated foods, having as result the ensurance of a body maximum protection (4, 5).
In need, the dairy products can be supplemented with liposoluble provitamins / vitamins (A and/or D), with hydrosoluble vitamine (niacine, tiamine, riboflavin, ascorbic acid) or with biominerals, such as: iron, iodine, fluor etc. (6, 7).
Some works tried to evidence the effect of certain admixtures on biochemical processes, having, indirectly, in view the changes occured within transformations of carbohydrates and proteins made by lactic bacteria (8).
In this work there was searched the influence of some hypothermic shocks and admixtures of starch or gelatin, during yoghurt processing, on some yogurt

features (pH, titratable acidity and curd aspect).

2. Experimental

The biological material used in this work, was represented by cow milk, whose biochemical features are rendered below:
- pH: 6.90
- acidity (Törner degrees): 20°T
- fats: 1.99%
- proteins: 3.50%
- lactose: 4.40%
- dry matter: 9.85%
- minerals: 0.08%

The milk was inoculated with a starter culture of thermophile lactic bacteria, used for direct inoculation within the tub for yoghurt. The starter culture (a fine liofilisated powder) has included two lactic bacteria different species: *Streptococcus termophilus* and *Lactobacillus bulgaricus.*

The thermostating temperature was 43°C during 5 hours, and the inocul dose was 5UA/100 L.

The milk was conditioned with powder milk (20 g/L) and pasteurised 20-30 minutes at 90°C. For some work variants there were used only milk or milk with different admixtures.

The experiments during yoghurt processing have consisted in subjecting of samples to hypothermic shocks, on the one hand, and introducing of some admixtures (starch or gelatin), in certain proportions, on the other hand, to see the influence of these experiments on the evolution of pH, titratable acidity and quality characteristics of curd particles of yoghurt.

Thermal shocks have been carried out by subtracting fast of temperature milk sowed and thermostated after certain time intervals, in order to achieve in the end t=20°C. Samples were kept in the freezer for 10 minutes, then in the refrigerator for 5 minutes.

Thermal shocks have been performed after: 30, 90, 150 and 210 of thermostating minutes at temperature 43°C, and determinations of above mentioned indices, have been carried out hour by hour during yoghurt processing.

The percentage of admixtures used are rendered below:

Table 1
The percentage of admixtures

Admixtures							
Starch %	0.5	1.5	2.5				
Gelatin %				0.5	1.5	2.5	

The samples with admixtures for trials are played in the table no. 2:

Table 2
The samples with admixtures for trials

Admixture Sample	**Starch (%)**	**Gelatin (%)**
P1	-	-
P2	0.5	-
P3	1.5	-
P4	2.5	-
P5	-	0.5
P6	-	1.5
P7	-	2.5

The determination of the titratable acidity, expressed in Thőrner degree (°T), was made according to AOAC standard (9), and the pH values were estimated according to STAS 8201/82 (10).

As seen in the table 1, in blank (P1) pH values fell from 6.6 (after first time keeping in the oven), to pH 4.6 (after 5 hours) - the difference being 2 pH units.

The acidity of milk (sowed with starter culture) after the first thermostating hour was 25°T, and in the second hour this index has grown very little (with only 4°T). Visible changes occurred between 2 hour (29°T) and 3 hours of termostating process (56°T) – an extra of 27°T, respectively between 4 hour (61°T) and the 5th termostating hour (82°T) - that an increase by 21°T. In blank, between the initial and the final titratable acidity value reveals a difference of 57°T.

Table 3
Values of pH and titratable acidity of yogurt samples, subjected to thermal shocks

The sample number and range of application of thermal shock from the start of thermostating process	Analyses made	Thermostating duration				
		1 h	2 h	3 h	4 h	5 h
P1 (blank)	pH	6.60	6.48	5.65	4.80	4.60
	Acidity (°T)	25	29	56	61	82
P2 (hypothermic shock after 30 thermostating minutes)	pH	6.56	6.51	6.42	6.39	6.15
	Acidity (°T)	22.0	23.5	25.3	26.5	30.3
P3 (hypothermic shock after 90 thermostating minutes)	pH	6.47	6.40	6.35	6.40	6.20
	Acidity (°T)	22.5	23.5	25.0	29.5	30.0
P4 (hypothermic shock after 150 thermostating minutes)	pH	6.50	6.48	5.60	5.20	4.90
	Acidity (°T)	25.2	35.5	53.4	58.2	72
P_5 (hypothermic shock after 210 thermostating minutes)	pH	6.50	6.45	5.60	5.10	4.80
	Acidity (°T)	25.5	34	56	65	78

In sample P2, pH values fell from pH 6.56, after the first thermostating hour, to pH 6.15 (after 5 hours) – a more pronounced decrease being registered from 3 to 5 hours of processing (0.27 pH units). As to titratable acidity, the growth of this index was higher between the 3rd and the 5th thermostating time (5°T) compared with the interval 1-3 hours (3.3°T).
Compared with the blank, in sample P2, which suffered thermic shock after 30 minutes of thermostating, it can see that the hypothermic impact (suffered in that time), was much felt by the starter bacteria, whose enzymatic activity has been drastically reduced, manifested by growth, in the end, of the titratable acidity with only 8.3°T.
Sample P3, which underwent hypothermic shock after 90 minutes of thermostating, recorded values very close to those of the sample P2, in terms of pH and titratable acidity.
Thus, the pH values fell from pH 6.47, after the first thermostating hour, to pH 6.2 (after 5 hours) – a more pronounced decrease being registered from 3 to 5 hours of processing (0.25 pH units).
In sample P3, the growth of the titratable acidity was higher between the 3rd and the 5th thermostating time (5°T) compared with the interval 1-3 hours (2.5°T).
When the hypothermic shock has been applied after 150 minutes of termostating (sample P4), the pH value has decreased, in the end, with 1.60 pH units; a more pronounced reduction being in the range of 1 to 3 hours (0.9 pH units beside 0,7 pH for range of 3 to 5 hours).
In P4 sample, the titratable acidity has increased from 25.2°T, after the first time, at 72°T, after 5 hours, that is with 46.8°T. In this case, the biggest increase of this index was in the range of 1 to 3 hours of thermostating (with 28.2°T).
Sample P5 underwent hypothermic shock after 210 minutes of thermostating. In this sample, pH values has decreased, in the end, with 1.7 pH units, a more pronounced reduction being in the range of 1 to 3 hours (0.9 pH units beside 0.8 pH for range of 3 to 5 hours).

Table 4
Noting of curd is played as follows:

0	Negative
+ –	Very weak curd
+	Curd begins to form
+ +	Curd formed
+ + +	Well-formed curd
+ + + +	Very well-formed curd

In the same sample, the titratable acidity has increased from 25.5°T, after the first time, at 78°T, after 5 hours, that is with 52.5°T. In this last case, the biggest increase in this index was in the range of 1 to 3 hours of termostating (with 30.5°T).
In the table 5 is reproduced the evolution of milk coagulation under hypothermic shocks.

Table 5
The comparative evolution of milk coagulation during yoghurt processing, in terms of thermal shocks application

The sample number and range of application of thermal shock from the start of thermostating process	The coagulation evolution of milk sowed with starters cultures, during thermostating period				
	1 h	**2 h**	**3 h**	**4 h**	**5 h**
P_1 (blank)	0	+ +	+ +	+ + +	+ + + +
P2 (hypothermic shock after 30 thermostating minutes)	0	0	0	0	0
P3 (hypothermic shock after 90 thermostating minutes)	0	+ –	+ –	+	+
P4 (hypothermic shock after 150 thermostating minutes)	0	+ +	+ +	+ +	+ +
P_5 (hypothermic shock after 210 thermostating minutes)	0	+ +	+ +	+ + +	+ + +

As seen in table 2, the milk coagulation during yoghurt processing had a different evolution in samples subjected to hypothermic shocks compared to blank. In blank (P1), the curd was: formed (after 2 and 3 hours), well-formed (after 4 hours) and very well-formed (after 5 hours). If in the sample P2 the curd has not appeared at all during yoghurt processing, in the other samples the curd had a different evolution, depending on the application of hypothermic shock. Thus, in P3 after 2 and 3 hours the curd has been very weak, and after 4 and 5 hours its aspect was of curd which begins to form.
In the sample P4, the curd was formed after 2 hours, and it was maintained in this form up to the end of process (without being well-formed).
In the sample P5, the curd was formed after 2 hours, then it bacame very well-formed after 4 hours, and it was maintained in this form up to the end of process.
Application of hypothermic shock in the early period of thermostating (the sample P2) has made the coagulation process of milk to be blocked. The later applied hypothermic shock, the lower effect on coagulation process was (samples 4 and 5).
The table 3 reproduces pH and acidity values of yoghurt samples, with addition of starch or gelatin.
According to the table 3, in blank (P1) pH values fell from 6.6 (after first hour) to 4.6 (after 5 hours of thermostating). The tiratable acidity of blank registered a difference of 57°T between the initial value (25°T) and the final value (82°T) of this index.

Table 3
Biochemical index values of yoghurt samples, with addition of starch and gelatin, in certain proportions

The sample number and the compound added	Analyses made	Thermostating duration				
		1 h	2 h	3 h	4 h	5 h
P_1 (blank)	pH	6.60	6.48	5.65	4.80	4.60
	Acidity (°T)	25	29	56	61	82
P_2 (0.5% starch)	pH	6.70	6.48	6.01	5.15	5.06
	Acidity (°T)	24.5	30	404	57	70
P_3 (1.5% starch)	pH	6.60	6.50	5.50	4.95	4.70
	Acidity (°T)	25	31.2	57	59.4	78
P_4 (2.5% starch)	pH	6.72	6.50	5.54	4.93	4.69
	Acidity (°T)	24.6	31	54	60.4	79
P_5 (0.5% gelatin)	pH	6.68	6.42	5.48	4.89	4.45
	Acidity (°T)	25	34.8	56.2	60	90
P_6 (1.5% gelatin)	pH	6.50	6.34	5.89	5.10	4.52
	Acidity (°T)	30.4	39.8	49.6	58.4	88
P_7 (2.5% gelatin)	pH	6.48	6.35	5.52	5.06	4.40
	Acidity (°T)	32.6	38.8	54.2	58	93

In the sample P2, (with 0.5% starch) pH values fell from pH 6.7, after the first thermostating hour, to pH 5.06 (after 5 hours). As to titratable acidity, the growth of this index was 45.5°T, and its final value (in the end of process) was 70°T.
In the sample P3 (with 1.5% starch) the pH values fell from pH 6.60, after the first thermostating hour, to pH 4.7 (after 5 hours). The titratable acidity has grown from 25 to 78°T (in the end of process), that is a difference of 53°T.
The sample P4 (with 2.5% starch) has registered a decrease of pH values from pH 6.72, after the first thermostating hour, to pH 4.69 (after 5 hours). The titratable acidity has grown from 24.6 to 79°T (in the end of process), that is a difference of 54.4°T.
In the sample P5 (with 0.5% gelatin) pH values fell from pH 6.68, after the first thermostating hour, to pH 4.45 (after 5 hours). As to titratable acidity, the growth of this index was 65°T - the final value of this index (after 5 hour of thermostating) being 90°T.
The sample P6 (with 1.5% gelatin) has registered a decrease of pH values from pH 6.50, after the first thermostating hour, to pH 4.52 (after 5 hours). The titratable acidity has grown from 30.4 to 88°T (in the end of process), that is a difference of 58.6°T.
In the sample P6 (with 2.5% gelatin) pH values fell from pH 6.48, after the first thermostating hour, to pH 4.40 (after 5 hours). As to titratable acidity, the growth of this index was 60.4°T - the final value of this index (after 5 hour of thermostating) being 93°T.
Comparing the values of the indexes in tab. 3, it can see that in the case of samples with gelatin admixture pH values were lower, and the titratable acidity higher than blank. Along with the increasing of gelatin amount added, the titratable acidity has grown too. In all samples with starch added, the titratable acidity value was less then blank.
It is known that pH and titratable acidity are biochemical indices expressing, indirectly, the fermentation activity of lactic bacteria. Since no starch or gelatin can be used directly as a source of carbon and energy by lactic bacteria cultures, this increasing of the fermentation activity (in

the case of gelatin addition) could be explained by the role of oxygen barrier that plays the gelatin inside emulsions (7). Limiting or blocking access of oxygen within emulsion (milk) mass, favors the fermentation activity of lactic cultures.
In the table 4 is rendered the evolution of milk coagulation during yoghurt processing.
As seen in table 4, the milk coagulation during yoghurt processing had a different evolution. In blank (P1), the curd was formed (after 2 and 3 hours), well-formed (after 4 hours) and very well-formed (after 5 hours).
In the sample P2 (0.5% starch) the curd was very weak after 2 and 3 hours, it began to form after 4 hours and is formed in the end of process.
At sample P3 (1.5% starch), the curd was very weak after 2 and 3 hours, it began to form after 4 hours, an was formed after 5 hours (in the end).
The curd of sample P4 (2.5% starch) was very weak after 2 and 3 hours, it began to form after 4 hours, and was wel-formed in the end of process.

Table 4

The comparative evolution of milk coagulation during yoghurt processing, in terms of some compound additions

The sample number and the compound added	The coagulation evolution of milk sowed with starters cultures, during thermostating period				
	1 h	2 h	3 h	4 h	5 h
P_1 (blank)	0	+ +	+ +	+ + +	+ + + +
P_2 (0.5% starch)	0	+ –	+ –	+	+ +
P_3 (1.5% starch)	0	+ –	+ –	+	+ +
P_4 (2.5% starch)	0	+ –	+ –	+	+ + +
P_5 (0.5% gelatin)	0	+ –	+	+ +	+ + +
P_6 (1.5% gelatin)	0	+ –	+	+ +	+ + + +
P_7 (2.5% gelatin)	0	+	+	+ +	+ + + +

Table 5

Noting of curd is played as follows:

0	Negative
+ –	Very weak curd
+	Curd begins to form
+ +	Curd formed
+ + +	Well-formed curd
+ + + +	Very well-formed curd

At sample P5 (0.5% gelatin), the curd was very weak after 2 hours, it began to form after 3 hours, it bacame formed after 4 hours, and well-formed after 5 hours (in the end).
In the sample P6 (1.5% gelatin) the curd was very weak after 2 hours, it began to form after 3 hours, was formed after 4 hours, and very well-formed in the end of process.
The curd of sample P7 (2.5% gelatin) began to form after 2 and 3 hours, it became formed after 4 hours, and very well-formed in the end of process.
Analysing the data in the table 4, it seems the addition of gelatine or starch has not

rushed the milk coagulation process during yoghurt processing. Compared to the control, in samples with admixtures the curd formation was slower, especially on samples with starch addition.

4. Conclusions

During yoghurt processing, the application of some hypothermic shocks and the introduction of some compounds has influenced the evolution of acidity and the milk coagulatin process.

Application of hypothermic shocks in the early period of thermostating has determined the decrease of fermentation activity of lactic bacteria (expressed by reduction of titratable acidity values) and has made the coagulation process of milk to be blocked. The later applied hypothermic shock, the lower effect on titratable acidity and coagulation process was.

The addition of gelatine or starch during yoghurt processing has influenced, indirectly, the fermentation activity of lactic bacteria. The gelatin addition has led to the increase of titratable acidity values, comparing to blank.

The addition of gelatine or starch has not rushed the milk coagulation during yoghurt processing. Compared to the control, in samples with admixtures the curd formation was slower, especially in those ones with starch addition.

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