INFLUENCE OF LIQUID PLASMA,PRE-GELATED PLASMA /RAW LIVEX/ AND WHITE LIVEX PROCESSED FROM STABILIZED PIG BLOOD PLASMA ON QUALITY OF MODEL COMMINUTED SCALDED SAUSAGES

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SUMMARY: Model,comminuted,scalded sausages were manufactured with substitution of meat tissue protein /beef,pork/ at 8% level using as a substitute:liquid commercially processed stabilized pig blood plasma,destabilized pig blood plasma /liquid form/,destabilized pre-gelated pig blood plasma /raw livex/and destabilized pre-gelated pasteurized pig blood plasma /white livex/.Technological,physico-chemical,rheological and organoleptical indices were used for assessment of substitutes influence on sausages quality. All of meat tissue protein substitute forms at 8% level substitution allow to manufacture sausages with high production yield /approx.130%/ and of fully accepted quality.The only exception was inferior influence of white livex on sausage colour physical parameters.

INTRODUCTION: Liquid,frozen,spray-dryed and processed blood plasma in form of a white livex i.e the product manufactured in accordance with the technology patented in Poland /3/ are commonly considered as meat protein substitute and/or components of comminuted sausages and/or canned meat products recipes.White livex is an structurized meat protein substitute produced from stabilized pig blood plasma and thereafter destabilized in order to reverse its properties to form a clot i.e. to gelate to a gel called raw livex before heat treatment /pasteurization/ which results in final products i.e. white livex whose texture and structure resemble cooked egg white./1,2,5,6/. The purpose of the experiment was to assess the influence of 4 forms of pig blood plasma used as a substitute of meat tissue protein on a selected quality indices /features/ of model,comminuted,scalded sausages.

MATERIALS and METHODS: Commercially manufactured pig blood plasma,stabilized with sodium citrate and it's modified forms was used as a substitute of meat tissue protein for model,com-

minuted,scalded sausages manufacturing.

Table 1. Recipes of experimental sausage.

Experiment Item /g/	A /control/	B	C	D	E
1.Beef /lean/	550,0	506,0	506,0	506,0	506,0
2.Pork /lean/	650,0	598,0	598,0	598,0	598,0
3.Back fat	240,0	240,0	240,0	240,0	240,0
4.Substitute	-	288,0[1]	288,0[2]	288,0[3]	288,0[4]
5.Water	480,0	288,0	288,0	288,0	288,0
6.NaCl	48,0	48,0	48,0	48,0	48,0
7.$NaNO_2$	0,24	0,24	0,24	0,24	0,24
8.Sodium ascorb.	1,38	1,38	1,38	1,38	1,38
9.Seasoning	2,50	2,50	2,50	2,50	2,50
10.L.S.P. /BRDW/	0,14	0,14	0,14	0,14	0,14

L.S.P. = Liquid smoke preparate

1.Liquid pig blood plasma processed from stabilized blood.
2.Destabilized pig blood plasma /liquid form/.
3.Destabilized pre-gelated pig blood plasma /raw livex form/.
4.Destabilized,pre-gelated,pig blood plasma pasteurized /livex/.

From the data in Table 1 follows that the meat tissue protein in sausage batters was partially replaced i.e. at 8% level /assuming 18% protein contents in meat tissue and 6% protein content in blood plasma/,with liquid blood plasma /B/ and its three modified forms /C,D,E/ each of different functional properties in comparison with commercially processed blood plasma due to different /modified/ form of fibrinogen /C,D/ and in form of heat denaturated proteins including fibrinogen /E/ i.e. in form of white livex.Sausage batters were filled into collagen casings of 35 mm in diameter and 200 mm in length.Sausages, after short time of batter settling, were than scalded in a water bath at 85°C until 80°C was reached in the core,and thereafter chilled for 5 min in cold runnig water.

Influence of substitution was assessed on a basis of the following indices:pH of plasma,white livex,sausage batters and final products,the amount of water and fat released from 30g

sample of sausage batter heated in glass container /beaker/ in water bath at 85°C for 40 min.,determination of batters viscosity using rotation viscosimeter Reotest - 2,determination of scalding weight loss and calculation of production yield after completing of processing and after 24 and 48 hours of refrigerated storage of final products.The colour physical parameters i.e. dominant wavelenght /λd/,the excitation purity /pe/ and the luminance /Y/ as well as the colour stability after 0, 3,6,9 and 12 hours of continuous illumination of sausage samples /slices/ by fluorescent white light with an intensity of 250 Lx were determined using the reflectance spectrophotometry.Selected rheological characteristic of the final products were assessed instrumentally using indurance machine Heckert type FP2-100 on a samples of 30 mm. in diameter and 20 mm in hight determining: destructive force /N/,deformation energy /J/ and degree of destructive deformation /%/.The value of force registered at 25% of deformation degree was considered as the gelling force /gelling capacity/.The organoleptic test was done using a 5 point scale by Tilgner /4/.Release of water and fat under casing,colour,consistency,texture,slice firmnes,taste,aroma,juiciness and saltiness were assessed,all of these indices with criterions of intensity and desireness /appetance/.The experiment was repeated 5 times.Experimental data were subjected to statistical analysis of variance.The significant differences between the means were determined at the level of p = 0,05.

RESULTS and DISCUSSION: The content of protein in liquid destabilized blood plasma,determined by Kieldahl method,was 5.89% ± 0.23% and in white livex 6.09% ± 0.24%.In order to maintain similar content of protein in all 5 experimental batches of sausages an average amount of 6.0% of protein in all four forms of substitutes and 18% in meat tissue /beef and pork/ was used for calculation.

Plasma used as a substitute in form of liquid stabilized plasma,destabilized liquid plasma and pre-gelated plasma have in average the pH = 7.44 ± 0.07,while white livex 7.65 ± 0.08.The pH of all 4 forms of substitutes used was in an alkaline range and influenced,statistically significantly /p=0.05/ the pH of sausage batters and ready products./Table 2/.

Table 2.Selected characteristics of sausage batter and processing parameters

Parameters	pH		Viscosity $\frac{N.s}{m^2}$ after		Thermal drip /%/	Yield /%/ after		
	Batter	Sausage	Comminution	30 min. of settling		Scalding--cooling	24h	48h
Experiment	n=15	n=15	n=15	n=15	n=15	n=5	n=5	n=5
A	$5,93^{a}$	$6,22^{a}$	$77,2^{c}$	$77,9^{b}$	$16;8^{a}$	$131,4^{a}$	$126,3^{a}$	$125,6^{ab}$
B	$6,08^{b}$	$6,30^{b}$	$67,1^{a}$	$70,3^{a}$	$16,9^{a}$	$132,5^{a}$	$126,8^{ab}$	$125,5^{ab}$
C	$6,09^{b}$	$6,28^{b}$	$70,1^{ab}$	$76,6^{b}$	$17,1^{a}$	$131,7^{a}$	$127,9^{b}$	$126,5^{b}$
D	$6,09^{b}$	$6,28^{b}$	$72,2^{b}$	$75,3^{b}$	$17,5^{a}$	$130,8^{a}$	$126,2^{a}$	$125,1^{a}$
E	$6,16^{c}$	$6,30^{b}$	$86,9^{d}$	$99,8^{c}$	$16,8^{a}$	$131,0^{a}$	$126,6^{a}$	$125,1^{a}$
LSD	0,04	0,04	3,57	4,02	0,89	2,02	1,28	1,26

Means with different superscripts in all tables are significantly different at $P \leq 0.05$.

Table 3.Rheological parameters of experimental sausages

Parameters	Destructive force /N/	Destructive deformation /%/	Gelation force /N/	Deformation energy /J/
Experiment	n=25			
A	83^{b}	$47,1^{b}$	26^{a}	$2,9^{b}$
B	69^{a}	$42,9^{a}$	27^{ab}	$2,3^{a}$
C	71^{a}	$41,6^{a}$	27^{ab}	$2,4^{a}$
D	72^{a}	$42,0^{a}$	28^{b}	$2,4^{a}$
E	86^{b}	$45,8^{b}$	28^{b}	$3,1^{c}$
LSD	4,55	2,4	1,29	0,15

Addition of destabilized raw forms of plasma /B,C/ in comparison with control batter /A/ resulted in diminishing of sausage batters viscosity and white livex,i.e.pasteurized form of destabilized blood plasma,sharply increases the value of above mentioned parameter./Table 2/.Further although differenciated increase of sausage batters viscosity after 30 min.of settling was observed.The lowest viscosity value was determined for batter with addition of liquid stabilized plasma /B/ and sharp increase for batter substituted with white livex /E/. The mechanism of the above observation is unknown./Table 2/. The thermal drip ranged from 16.8% /A/ to 17.5% /D/ and observed differences was statistically insignificant./Table 2/.The production yield of all experimental batches of sausages,determined after completion of manufacturing,was similar i.e.in average 131%,which should be considered very high and satisfactory for the model assortment of sausages manufactured. During refrigerated storage differenciated weight loss was observed - the smallest one /5.2%/ after 48 hours of storage was determined for batch C i.e. processed with liquid destabilized plasma,while the greatest /7.0%/ for batch B manufactured with commercially procesed plasma,The weight losses observed after 48 hours of refrigerated storage for remaining experimental batches of sausages ranged from 5.7% /D/ to 5.9% /E/ /Table 2/.

The hardness indice of model sausages is correlated with batters viscosity data determined after comminution./Table 3/. Greater hardness was observed for batches A and E and significantly smaller for batches B,C and D.Similar dependence was observed analysing degree of destructive deformation./Table 3/. All forms of substitutes used desirably influenced,in comparison with control batch /A/,the value of force determined for 25% deformation i.e. the so called gelated force./Table 3/. The influence of substitutes used on values of deformation energy was similar to the ones observed for hardness and destructive deformation./Table 3/.The analysis of colour physical parameters data shows that incorporation of white livex into recipe of batch E undesirably influenced the colour of final products which is demonstrated in shortening of the

dominant wavelenght /λd/,decrease of excitation purity /pe/ and increase of luminance /Y/ in comparison with control batch. /Table 4/.

Table 4. Reflectance spectrophotometric colour characteristics

Parameters of colour	Dominant wavelenght λd /nm/				
Time of illumination /h/	0	3	6	9	12
Experiment	n = 15				
A	610,76^{c}	609,05^{b}	608,06^{b}	607,65^{b}	607,34^{c}
B	610,31^{bc}	608,69^{b}	607,76^{b}	606,80^{b}	607,04^{bc}
C	610,07^{b}	608,59^{b}	607,66^{b}	607,28^{b}	606,27^{b}
D	610,02^{b}	608,61^{b}	607,75^{b}	606,99^{b}	607,22^{bc}
E	608,16^{a}	606,41^{a}	605,56^{a}	605,06^{a}	604,86^{a}
LSD	0,53	0,76	0,90	0,93	0,95
	Luminance /Y/				
A	42,07^{a}	43,01^{a}	43,48^{a}	42,94^{a}	42,52^{a}
B	42,73^{a}	43,36^{a}	44,25^{ab}	44,33^{b}	43,70^{ab}
C	43,17^{ab}	43,83^{a}	44,27^{ab}	44,13^{ab}	44,55^{b}
D	43,86^{b}	45,02^{b}	45,22^{b}	45,40^{bc}	44,99^{b}
E	44,95^{c}	45,95^{b}	46,70^{c}	46,43^{c}	45,23^{b}
LSD	0,98	1,08	1,29	1,31	1,88
	Excitation purity /pe/				
A	0,468^{c}	0,457^{bc}	0,452^{b}	0,449^{b}	0,448^{b}
B	0,465^{bc}	0,461^{c}	0,450^{b}	0,446^{b}	0,448^{b}
C	0,463^{b}	0,454^{b}	0,450^{b}	0,447^{b}	0,443^{b}
D	0,463^{b}	0,455^{b}	0,450^{b}	0,446^{b}	0,446^{b}
E	0,453^{a}	0,443^{a}	0,441^{a}	0,439^{a}	0,431^{a}
LSD	0,003	0,004	0,005	0,005	0,006

Similar dependence was observed for the data determined for colour stability assessment.The influence on colour physical parameters of remained forms of substitutes used in comparison with the control one,was smaller and partly undetectable after

assessment of the colour stability i.e. after illumination of samples with fluorescent white light for up to 12 hours.Table 4. It also was observed that liquid stabilized plasma /B/do not influence the colour physical parameters in comparison with the control batch /A/.Substitution of meat protein with raw destabilized forms of plasma /batch C and D/also insignificantly influence of the colour physical parameters in comparison with the data observed for the control batch,while white livex form /E/ results in substantial deviation of determined parameters in relation to the other experimental batches and the control one./Table 4/.

Results of organoleptic analysis allow to conclude that the quality indices of all kinds of experimental model sausages were comparable and similar./Table 5/.

Table 5.Organoleptic characteristics of experimental sausages

Experiment		A	B	C	D	E	LSD
Parameters		n = 30					
Colour	I	$4,43^{a}$	$4,38^{a}$	$4,42^{a}$	$4,23^{a}$	$4,28^{a}$	0,27
	A	$4,40^{a}$	$4,30^{a}$	$4,48^{a}$	$4,38^{a}$	$4,55^{a}$	0,26
Texture	I	$4,53^{a}$	$4,33^{a}$	$4,47^{a}$	$4,50^{a}$	$4,43^{a}$	0,28
	A	$4,50^{a}$	$4,50^{a}$	$4,56^{a}$	$4,40^{a}$	$4,47^{a}$	0,30
Cohesiveness	I	$4,60^{b}$	$4,27^{a}$	$4,45^{ab}$	$4,53^{b}$	$4,50^{ab}$	0,28
	A	$4,67^{a}$	$4,53^{a}$	$4,62^{a}$	$4,60^{a}$	$4,73^{a}$	0,25
Flavour	I	$4,53^{a}$	$4,47^{a}$	$4,47^{a}$	$4,37^{a}$	$4,27^{a}$	0,29
	A	$4,53^{a}$	$4,45^{a}$	$4,52^{a}$	$4,55^{a}$	$4,50^{a}$	0,29
Aroma	I	$4,38^{a}$	$4,28^{a}$	$4,40^{a}$	$4,32^{a}$	$4,45^{a}$	0,24
	A	$4,42^{a}$	$4,28^{a}$	$4,40^{a}$	$4,40^{a}$	$4,30^{a}$	0,23
Saltiness	I	$4,58^{a}$	$4,56^{a}$	$4,53^{a}$	$4,48^{a}$	$4,51^{a}$	0,24
	A	$3,65^{a}$	$3,68^{a}$	$3,63^{a}$	$3,60^{a}$	$3,65^{a}$	0,30
Juiciness	I	$4,53^{a}$	$4,46^{a}$	$4,60^{a}$	$4,58^{a}$	$4,55^{a}$	0,23
	A	$4,47^{a}$	$4,53^{a}$	$4,48^{a}$	$4,58^{a}$	$4,60^{a}$	0,23

I = Intensity A = Appetence

Comparable were also the data determined for desirability and intensity of assessed organoleptić indices.An average scoring was not lower than 4.27 points in 5 point scale.The only difference observed was the desirability of saltiness which oscillated below 4.0 points,but this does not negativelly influence the average scoring of organoleptic quality of experimental sausages.The only significant difference observed for the criterion of intensity was the slice cohesiveness being slightly inferior on comparison with control batch /A/ and sausages processed with pre-gelated plasma as a component of a recipe /D/.Release of water and fat under casing was not observed for all of model sausages batches.

Taking into consideration the results obtained for all of the indeces used for assessing the influence of the experimental substitutes on the quality of model sausages it could be concluded,that destabilized pig blood plasma i.e. in form of raw livex as well as in pasteurized form /white livex/ can be used as a substitute of meat tissue protein for comminuted, scalded sausages manufacturing.Both above forms of plasma apart from being substitutes could also be considered as an natural modulator of sausage batter rhelogical properties and a texture of final product.

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