A STUDY ON THE FUNCTIONAL PROPERTIES OF SUNFLOWER PROTEIN CONCENTRATE WITH A VIEW TO ITS APPLICATION IN COOKED SAUSAGES. I. WATER-HOLDING CAPACITY AND SOLUBILITY STUDY.

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SUMMARY: The use of non-meat materials has proved to be a steady tendency in the preparation of meat products. At present, they are most frequently introduced in cooked sausages. The preparation offered by us is characterized by a high level of vegetable proteins and other physiologically important substances like nutritive fibres, etc.

In the present work it has been studied the water-holding capacity of the above preparation with various grain sizes (350-500 μ ; 275-300 μ ; 190-275 μ ; below 190 μ) in relation to water and a 2% aqueous solution of salt at different ratios. The preparation solubility was studied under the same conditions following 1 and 2 hours rest of the samples.

The results indicate that the preparation with a grain size below 190 μ has the highest water-holding capacity and solubility. The change in the water-holding capacity of the concentrate at different ratios is one and the same in character both for water and the 2% salt solution.

INTRODUCTION: In the production of sunflower oil and after its separation from the seeds there remains a by-product that can be used as an additive in the production of a number of foodstuffs, and of meat products as well. The aim of the present work is to study the functional properties (water-holding capacity and solubility) of that by-product after it is ground to particles with a fixed size in view of its application as an additive in cooked sausages.

MATERIALS AND METHODS: Our sunflower protein concentrate was obtained by grinding sunflower seeds whose oil had been extracted in advance. The concentrate was prepared in four versions depending on the grain size: I - 350-500 μ ; II - 275-350 μ ; III - 190-275 μ ; IV - below 190 μ . The basic composition of the sunflower concentrate was as follows: water, 8.1%; protein (for absolute dry matter), 45.5%; fats (for absolute dry matter), 2.1%; nutritive fibres (for absolute dry matter), 13.1%.

The water-holding capacity of the preparation was studied for water and a 2% aqueous solution of salt. Samples were prepared by adding water or salt solution to the sunflower concentrate so as to obtain the following ratios: 1:5, 1:6, 1:7, 1:8. The mixtures were then stirred in a homogenizer at 1 000 min^{-1} for 5 min and were after that centrifuged in a laboratory centrifuge at 1 000 min^{-1} for 5 min. The centrifugation over, the amount of the exuded water and the percentage of the retained water were measured.

The preparation solubility was determined only for water. Samples were prepared by addition of water to a respective proportion of the sunflower concentrate to get the following ratios: 1:7, 1:8, 1:9, 1:10. The samples thus prepared were stirred in a homogenizer at 1 000 min^{-1} for 1 min, and after that were left for 1 and 2 hours at room temperature and stir-

red at 15 min intervals. Then the samples were centrifuged in a laboratory centrifuge at 1 000 min^{-1} for 5 min. After the centrifugation the thick residue was weighed, and the percentages of the exuded water and retained water were determined thus characterizing the preparation solubility.

The results obtained from the experiments were processed by the methods of mathematical statistics (Voznesenski, V.A., 1969; Smirnov, N.V. et al., 1965); the tables given below contain the end results with $M \pm t.m$ confidence interval, where M is an arithmetical mean from n=9, m is mean-square error of the mean result, and t is Student's criterion for the 95% confidence interval assumed by us.

RESULTS AND DISCUSSION: The results for the sunflower concentrate water-holding capacity for water are given in Table 1 and for 2% salt solution in Table 2.

Table 1

Grain Size	Concentrate: Water Ratio	Concentrate (g)	Water (cm^3)	Exuded Water (cm^3)	Retained Water (%)	Non-retained Water,%
I	1:5	5	25	4.8 ± 0.28	80.8	19.2
350 +	1:6	5	30	16.4 ± 0.33	45.3	54.7
500 μ	1:7	5	35	19.0 ± 0.49	45.7	54.3
	1:8	5	40	25.4 ± 0.56	36.5	63.5
			Mean:	16.4 ± 0.63	52.07	47.93
II	1:5	5	25	5.8 ± 0.33	76.8	23.2
275 +	1:6	5	30	10.4 ± 0.55	64.7	35.3
350 μ	1:7	5	35	18.0 ± 0.48	48.6	51.4
	1:8	5	40	25.6 ± 0.68	36.0	64.0
			Mean:	14.95 ± 0.71	56.52	43.48
III	1:5	5	25	3.6 ± 0.28	85.6	14.4
190 +	1:6	5	30	8.6 ± 0.37	71.3	28.7
275 μ	1:7	5	35	24.2 ± 0.83	30.9	69.1
	1:8	5	40	25.4 ± 0.87	36.5	63.5
			Mean:	15.45 ± 0.82	56.07	43.93
IV	1:5	5	25	4.8 ± 0.31	80.8	19.2
below	1:6	5	30	8.2 ± 0.22	72.7	27.3
190 μ	1:7	5	35	11.4 ± 0.36	67.4	32.6
	1:8	5	40	16.2 ± 0.57	59.5	40.5
			Mean:	10.15 ± 0.81	70.10	29.90

The results in Tables 1 and 2 show that the grain size of the concentrate in the studied range does not bear significant influence on its water-holding capacity in the cases of water treated samples as well as with the samples treated with 2% salt solution. More expressed is the difference in the water-

holding capacity between concentrate version IV and the remaining three versions. The concentrate version with the smallest grain size (below 190 μ) exhibits the best water-holding capacity (corresponding to the least amount of centrifugally exuded liquid phase) both for water and 2% salt solution. The water-holding capacity of the concentrate for water indicates that it depends to a certain extent on the size of the ground particles although this tendency is not strongly expressed. The concentrate with grain size 350-500 μ shows the lowest water-holding capacity that corresponds to the greatest amount (16.4±0.63) of exuded water. The treatment with 2% salt solution does not support this tendency.

Table 2

Grain Size	Concentrate: Salt Solution Ratio	Concentrate (g)	Salt Solution (cm^3)	Exuded Salt Solution (cm^3)	Retained Salt Solution (%)	Non-retained Salts (%)
I	1:5	5	25	9.2±0.21	63.2	36.8
350 +	1:6	5	30	10.0±0.32	66.7	33.3
500 μ	1:7	5	35	18.6±0.54	46.9	53.1
	1:8	5	40	18.2±0.48	54.5	45.5
			Mean:	14.00±0.62	57.82	42.18
II	1:5	5	25	3.2±0.27	87.5	12.5
275 +	1:6	5	30	13.6±0.43	54.7	45.3
350 μ	1:7	5	35	14.4±0.56	58.9	41.1
	1:8	5	40	28.0±0.78	30.0	70.0
			Mean:	14.80±0.71	57.77	42.23
III	1:5	5	25	6.8±0.33	72.8	27.2
190 +	1:6	5	30	10.7±0.47	64.3	35.7
275 μ	1:7	5	35	23.6±0.55	28.5	71.5
	1:8	5	40	23.2±0.82	42.0	38.0
			Mean:	16.07±0.68	51.90	48.10
IV	1:5	5	25	4.0±0.18	84.0	16.0
below	1:6	5	30	9.2±0.53	69.3	30.7
190 μ	1:7	5	35	14.0±0.62	60.0	40.0
	1:8	5	40	17.6±0.63	56.0	44.0
			Mean:	11.20±0.66	67.32.	32.68

The results also indicate that while the ratio between the concentrate and the added component (water or 2% salt solution increases its water-holding capacity decreases. The highest percentage of retained water was at a ratio 1:5. While with water-treated samples this tendency is clear enough there are some exceptions with the samples treated with 2% salt solution. Thus for example, when the ratio increases the water-holding capacity decreases steadily only with version IV.

The results for the sunflower concentrate solubility are given in Tables 3 and 4. They point out that with versions I, II and III the grain size has almost no effect on the concentrate solubility regardless the duration of holdup (1 or 2 hours). The results for the residue weight and the percentages of the retained and exuded water do not differ statistically with different versions. The minimum differences that were received obviously fall within the confidence interval.

There is a qualitative difference established in the properties of the concentrate with grain size below 190 μ. This concentrate version is marked by better solubility because, regardless the duration of holdup, the amount of the residue and the percentage of the retained water are the least.

Solubility at 1 h holdup duration — Table 3

Grain Size	Concentrate: Water Ratio	Concentrate (g)	Water (cm^3)	Residue Weight (g)	Retained Water (%)	Exuded Water (%)
I 350 + 500 μ	1:7	5	35	24.24±0.64	55.0	45.0
	1:8	5	40	24.40±0.88	39.0	61.0
	1:9	5	45	25.00±0.53	44.4	55.6
	1:10	5	50	25.30±0.79	49.4	50.6
			Mean:	24.73±0.73	46.95	53.05
II 275 + 350 μ	1:7	5	35	25.32±0.71	58.1	41.9
	1:8	5	40	25.31±0.73	50.8	49.2
	1:9	5	45	26.55±0.48	41.0	59.0
	1:10	5	50	26.56±0.51	46.9	53.1
			Mean:	25.93±0.66	49.20	50.80
III 190 + 275 μ	1:7	5	35	23.60±0.72	53.1	46.9
	1:8	5	40	24.90±0.60	49.7	50.3
	1:9	5	45	24.45±0.53	43.2	56.8
	1:10	5	50	25.15±0.77	40.3	59.7
			Mean:	24.52±0.67	46.58	53.42
IV below 190 μ	1:7	5	35	23.50±0.48	52.9	47.1
	1:8	5	40	22.25±0.51	43.1	56.9
	1:9	5	45	22.60±0.63	39.1	60.9
	1:10	5	50	22.75±0.41	35.5	64.5
			Mean:	22.75±0.52	42.65	57.35

In the ranges studied by us it was not established a definite effect of the different concentrate:water ratios on the concentrate solubility. The differences between the different concentrate versions are insufficiently expressed.

Solubility at 2 h holdup duration — Table 4

Grain Size	Concentrate: Water Ratio	Concentrate (g)	Water (cm^3)	Residue Weight (g)	Retained Water	Exuded Water
I	1:7	5	35	23.65±0.59	53.3	46.7
350 +	1:8	5	40	25.30±0.67	50.7	49.3
500 μ	1:9	5	45	25.15±0.72	44.8	55.2
	1:10	5	50	23.45±0.83	36.9	63.1
			Mean:	24.38±0.73	46.42	53.58
II	1:7	5	35	23.00±0.88	51.4	48.6
275 +	1:8	5	40	23.72±0.71	46.8	53.2
350 μ	1:9	5	45	25.65±0.55	43.0	57.0
	1:10	5	50	24.95±0.48	39.9	60.1
			Mean:	24.33±0.72	45.27	54.73
III	1:7	5	35	23.60±0.59	53.1	46.9
190 +	1:8	5	40	24.00±0.63	47.5	52.5
275 μ	1:9	5	45	26.13±0.37	47.0	53.0
	1:10	5	50	25.23±0.49	40.5	59.5
			Mean:	24.74±0.48	47.02	52.98
IV	1:7	5	35	23.90±0.88	54.0	46.0
below	1:8	5	40	23.50±0.62	46.3	53.7
190 μ	1:9	5	45	23.40±0.54	40.9	59.1
	1:10	5	50	22.20±0.66	34.4	65.6
			Mean:	23.25±0.68	43.90	56.10

CONCLUSION: The study on the functional properties of the sunflower protein concentrate prepared in four versions depending on their grain size established that the version with the finest grain size (below 190 μ) has the best water-holding capacity and solubility. It has also a better water-holding capacity in relation to a 2% salt solution.

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