COMPARABLE STUDIES OF FUNCTIONAL PROPERTIES OF REDUCED FAT GROUND BEEF AND MECHANICALLY DEBONED POULTRY SYSTEMS WITH VEGETABLES

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BACKGROUND

Lately, with the attention being largely concentrated on the replacement of a portion of fat by non-meat components (water, protein and polysaccharide additives and their blends) (Keeton 1991, 1996; Mittal and Barbut, 1993; Jimenez-Colmanero, 1996; Ertas, 1997), very little study is actually given to vegetables, as a potential component of reduced fat products (Kažemėkaitytė and Šimkevičienė, 2000). Meat products quality and stability during the thermal and storing processes are inseparable from the functional qualities of the component in the formulation as well as the interaction of the components. Consequently, analysis of the functional qualities of individual non-meat component is essential, when combinations of the components are selected and their influence on reduced fat meat products is defined.

OBJECTIVES

The objective of this study was to investigate the fat- and water-holding capacity of comminuted systems based on mechanically deboned poultry (MDP) as well on beef shoulder meat (BSM) with vegetables, estimate the cook losses of that systems and evaluate an influence of vegetables on the above mentioned functional properties.

In terms of technology and nutrition, the most important are the polysaccharides, which mainly includes dietary fibres and starch. The major part of the latter consists of insoluble fibres fraction. Thus, the content of cellulose, hemicellulose, lignin, pectin and starch in dried vegetables was established.

MATERIAL AND METHODS

Two type of ground model reduced fat products with vegetables have been constituted, where BSM and pork back fat mixture (MJ) as well as MDP (MV) have been chosen as the key raw material. The chosen BSM and back fat ratio (85:15) in the mixture is aimed to form a mixture, the composition whereof is similar to MDP. From 10 % to 30 % of meat raw material has been replaced by rehydrated vegetable. The roots of dried and milled till the particle size 1 mm vegetables were rehydrated for approx. 30 min. in the next proportions: leek 1:6; celery 1:5,5; parsnip 1:4,5; parsley 1:4,5; topinambur 1:4. All components were mixed with 1,2% salt in laboratorial mixer for 2 min. The net test (Hermansson & Lucisano, 1982) was used to determine the water- and fat-holding properties of the MDP-vegetables systems by heating samples (n=6) in the tubes in a water bath at 77°C for 35 min. The samples were centrifuged for 20 min. at a speed of 2400 rpm after heat treatment. The content of protein, fat and water content of all samples were analysed (AOAC). Krushner-Haffer method was used for vegetable cellulose content, modified Klasson method was used for lignin, and Van Soest method for hemicellulose. The model products have been analysed by light microscopy.

RESULTS AND DISCUSSION

First thing during the experiment, was the investigation of the effect of the amount of rehydrated vegetables, used instead of some meat raw material. In order to eliminate the influence of the moisture and fat content of individual product batches, the water and fat losses were given in percent of the product moisture (WLW) or fat (FLF). As illustrated in Table 1, with the rehydrated vegetable content being increased from 10 % to 30 %, the amount of water and fat, which were not bound during the thermal process, increases ($P < 0.05$). Slight exponent fluctuations among different batches were related to the raw material composition as well as pH value. As was established by Troutt et all., 1992; Bloukas and Paneras, 1993; Claus and Hunt, 1993; Chin et all., 1999 the addition of a non-meat component or the reducing fat content actually does not alter the meat product pH, consequently the model beef and back fat mixture product pH was determined by beef pH. pH in different beef batches varied from 5.47 to 5.74, thus model products with higher pH values had better WHC. When the rehydrated vegetable content in the product was evenly increased form 10 % to 30 %, the amount of unbound water in products with different types of vegetables ranged from 2.5 to 4.7 % ($P < 0.05$). As the vegetable additive content became bigger ($P < 0.05$), model products with topinambur showed the biggest loss of water from the total moisture content in the product. Presumably, this is related to an insignificant content of fibre matters in topinambur (Tab. 2) as well as their vague WB property.

The deteriorating WHC of the model products is also related to the decreasing protein content. When some of the meat raw material is being replaced with rehydrated vegetable, the protein content in MJ/10 - MJ/30 products at average decreased by 5% ($P < 0.05$), compared to the protein content in model product MJ/10. Owing to the decreasing protein content, the protein gel network density may have reduced, consequently water was bound more weakly and was more easily released during the thermal process. A similar tendency was typical to MJ product fat loss dynamics. In this case, MJ/25 and MJ/30 products with parsnip, which, during the thermal process, lost 82-99 % ($P < 0.05$) of fat of the total fat content in the product stood out among others. The reason might have been the fact that the starch content in parsnip was found to be very high (up to 17.8 %), unlike in other investigated vegetables, with starch acting as the water binding, and not fat binding agent in chopped meat products.

As can be seen from Table 1, the increase of the content of added rehydrated vegetables in poultry model products (MV) was followed by the reduction ($P < 0.05$) of the content of water and fat which were not bound during the thermal process. The analysis of the possible impact of the meat raw material showed that, although the moisture and fat content in MV/0 products was at average 2 % higher, and the protein content about 3 % lower than in MJ/0 ($P < 0.05$), both product groups proved to have similar WLW indices, while during the thermal treatment the MJ/0 products lost about 16 % more fat of the total fat content than MV/0 ($P < 0.05$). The smaller fat loss may have been related to a higher MDP viscosity, compared to MJ, as well as higher pH. During the thermal treatment fat is better preserved in higher viscosity protein systems (Lin and Zayas, 1987), furthermore, owing to poultry muscle pH > 6, its proteins form stronger gel than lower acidity beef proteins do. As the quantity of added rehydrated vegetables increased, the water loss of poultry products evenly decreased ($P < 0.05$). The effect of the celery additive was especially noticeable in MV/20, MV/25 and MV/30 model products, which retained 72-76 % ($P < 0.05$) of the total moisture content during the thermal process. That supports our presumption about the probable inter-reliance of product WHC ability and the content of proteins and fibres in the product.

Similarly to the water loss, the fat loss reduced when the amount of the rehydrated vegetables increased ($P < 0.05$). The decrease of the fat loss may at the first place be attributed to the reduction of the total fat content in the products. Although in the case of the MJ model products, the observed opposite tendency implies that the product fat losses are rather related to the binding ability of the whole system than the fat content. Smaller total thermal losses, compared to MJ products, are characteristic of MV model products with any quantity of rehydrated celery, while the losses for both control MV and MJ products (without vegetables) were very similar.

Results of light microscopy shoud that the poultry fat cells have a similar size like the beef fat cells (the average area is 6.7×10^3 µm), thus it is probable that during the MDP production majority of the fat cells are damaged, and the fat squeezed out of them spread freely in the mechanically deboned meat. The MDP fat was dispersed mainly in the form of small droplets. Apparently, due to such fat dispersity and low poultry fat melting temperature, the fibre net of the vegetables incorporated into MDP absorbed fat into its structure much easier than it was the case with MJ. Since the muscle and the connective tissue structure is largely damaged during the mechanical deboning process, MDP is a semi-emulsified preparation, thus it is likely that in comparison with ground beef MDP possesses a bigger quantity of functional proteins which are able to participate in the protein interaction with proteins as well as protein interaction with water, with no additional operations required.

Conclusion

The findings imply that different thermal loss variation tendencies of the beef and poultry model products are related both to the quantity and composition of the incorporated rehydrated vegetables and to technological peculiarities of the meat raw material used for the product. Thus, it is apparent that the influence of an individual component may not be analysed isolated from the whole meat product system. To summarise the study results, it may be noted that, owing to specific chopping, pH and product structure, MV model products with analogous vegetables and equivalent quantity thereof demonstrated better WHC and FHC properties than MJ products. According to the findings, from the technological point as much as 30 % of rehydrated vegetables may be used in MV model products, whereas MJ products with more than 20 % of vegetables must be stabilised with additional functional components.

Pertinent literature

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Table 1. Thermal losses (%) of ground beef (MJ) and poultry (MV) model products with vegetables

with	LOSS	MJ/0	MJ/10	MJ/15	MJ/20	MJ/25	MJ/30	MV/0	MV/10	MV/15	MV/20	MV/25	MV/30
CELERY	TL	34.82±0.97	35.82±1.07	38.01±0.93	38.35±1.70	38.77±1.68	39.74±0.81	35.85±1.34	29.32±2.00	26.27±0.79	22.29±1.52	19.22±1.32	18.87±1.74
	WLW	38.63±1.61	40.68±1.52	43.36±1.65	43.45±2.00	43.93±1.26	45.33±1.27	40.89±1.89	36.17±2.79	32.56±1.01	28.04±1.99	24.10±1.59	23.73±2.25
	FLF	68.14±4.06	66.66±4.16	70.83±3.07	71.40±3.35	71.40±4.09	75.65±5.07	53.24±2.99	33.18±2.63	28.30±2.12	19.86±1.06	16.65±1.29	15.72±1.24
PARSNIP	TL	40.59±2.01	39.82±2.02	40.63±1.18	41.26±0.97	40.90±1.56	41.57±0.81	36.85±2.08	32.08±1.14	27.47±1.12	26.04±0.56	26.10±1.37	26.94±1.04
	WLW	47.90±1.45	45.71±1.46	47.43±1.92	48.66±1.22	46.62±2.23	47.02±1.87	43.77±1.62	39.82±1.72	35.04±1.72	33.82±0.66	34.76±1.60	35.65±1.22
	FLF	66.15±5.19	72.48±3.03	75.82±3.31	76.44±3.95	83.79±2.37	98.34±3.93	47.09±1.85	32.16±2.51	25.03±1.78	20.49±1.32	17.62±0.93	15.86±1.24
LEEK	TL	36.16±1.81	36.05±1.73	37.15±0.74	38.86±1.31	38.77±1.30	41.43±2.11	36.63±2.01	30.22±1.36	26.55±1.15	23.68±1.39	22.26±1.16	22.11±1.14
	WLW	42.23±1.22	41.71±1.95	43.60±1.25	44.30±1.57	44.85±1.15	49.08±2.86	42.71±2.20	37.46±1.52	34.33±1.22	30.34±1.16	28.65±1.61	29.34±1.50
	FLF	62.16±3.17	65.74±3.28	71.13±3.11	73.66±3.36	73.10±4.70	71.18±4.16	49.90±3.43	31.99±2.38	19.29±1.48	17.72±1.14	13.86±0.79	7.25±0.53
PARSLEY	TL	37.46±1.71	38.05±1.43	39.31±0.96	39.82±0.79	40.03±0.82	41.20±1.22	36.23±0.78	30.15±1.01	28.18±1.41	25.61±1.12	26.26±1.23	26.14±1.56
	WLW	43.60±2.10	44.22±2.16	45.79±1.37	46.20±1.32	46.44±1.61	47.95±1.27	43.11±1.97	37.50±2.05	36.94±1.22	33.12±2.07	34.20±1.41	34.16±1.81
	FLF	64.26±3.44	70.66±5.15	74.10±5.20	71.93±4.23	75.98±5.30	81.90±3.39	43.59±3.52	30.10±1.95	19.98±1.48	17.83±1.27	15.71±1.08	15.47±1.09
TOPINAM	TL	36.78±2.32	40.59±1.88	41.67±1.56	41.93±1.89	43.78±1.82	46.15±1.88	35.29±2.36	29.94±1.35	28.99±1.55	26.66±1.47	25.62±1.21	26.05±1.48
	WLW	42.45±2.85	47.38±3.21	49.84±2.55	48.86±2.23	51.58±1.44	55.74±2.06	40.65±2.48	38.27±1.13	37.72±1.49	34.66±1.33	33.99±1.14	34.15±1.80
	FLF	67.40±5.03	71.78±4.58	72.62±3.31	76.38±3.20	75.10±3.28	76.07±4.74	47.18±3.51	24.33±1.30	23.12±1.60	19.42±0.94	14.83±0.99	15.01±0.96

TL– total thermal loss; WLW- water loss, % moisture content of the product; FLF – fat loss, % fat content of the product.
Means ± standard deviations. Mean values in columns are differed ($P<0.05$).

Table 2. Content (%) of dietary fibres and starch in the dry vegetables

Vegetables	Cellulose	Hemicelluloses	Lignin	Pectin	Starch
Parsnip	7.99 ± 0.72	6.83 ± 0.47	0.62 ± 0.09	2.33 ± 0.19	17.19 ± 0.49
Leek	8.09 ± 0.64	3.19 ± 0.60	1.34 ± 0.44	1.39 ± 0.31	1.14 ± 0.27
Topinambur	5.23 ± 0.67	5.76 ± 0.83	0.56 ± 0.24	1.00 ± 0.11	0.52 ± 0.22
Celery	9.27 ± 0.66	8.04 ± 0.68	0.89 ± 0.18	3.74 ± 0.31	6.04 ± 0.44
Parsley	8.47 ± 0.23	8.00 ± 0.74	1.20 ± 0.35	2.13 ± 0.08	2.95 ± 0.17

Means ± standard deviations. Mean values in the same row are differed ($P<0.05$).