THE EFFECT OF SOY PROTEIN CONCENTRATE ON PHYSICAL AND CHEMICAL PROPERTIES OF HUNGARIAN STYLE DRY SALAMI

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INTRODUCTION

The effect of soy proteins on fermented or dry sausages has been studied in the past (Ambrosiadis et al 1982, Berry et al 1979, Joseph et al 1978, Kadane 1979, Modic et al 1978, Modic 1979, Rao et al 1984). Research has indicated that 8-10% of the meat can be replaced with hydrated textured soy protein without changing the appearance or taste of the finished sausage (Modic et al 1978, Modic 1979). Meat processors using a combination of isolated soy protein and textured soy protein concentrate (TSPC) in fermented sausage found dry time and weight losses reduced, with improved firmness and slicability (Kadane 1979). Research conducted at the Central Soya Meat Laboratory, U.S.A., was designed to determine the effect of replacing 8% to 14.9% of the meat with various forms of soy protein concentrate (SPC) and the method of incorporating the soy with the meat on chemical and physical properties of Hungarian Style dry salami. Three forms of SPC were tested (table 1), soy protein concentrate granules (SPCG), textured soy protein concentrate (TSPC), and functional soy protein concentrate (FSPC). The methods of incorporating the soy included hydrating the soy prior to chopping with the meat, dry addition, and injecting the soy into whole boneless pork shoulder. Previous unpublished Central Soya research demonstrated that dry salami made by dry addition of FSPC had objectionable visual pockets of dry soy in the finished salami. To eliminate this problem a portion of the FSPC was pre-hydrated with water (1 protein: 6.8 water;w/w) and injected into whole boneless pork shoulder.

Table 1--Soy Protein Concentrate Specifications

Size	SPCG[1] 0.24-0.83mm	TSPC 3mm (flake)	FSPC Powder
Min. % Protein Dry Basis	70.0	70.0	70.0
Max. % Moisture	10.0	10.0	10.0
Max. % Fat	1.5	1.5	2.0
Max. % Crude Fiber	4.5	6.0	5.0

[1] SPCG - Soy Protein Concentrate Granule;
TSPC - Textured Soy Protein Concentrate;
FSPC - Functional Soy Protein Concentrate.

MATERIALS AND METHODS

Six treatments (TRT) of dry salami were formulated as shown in table 2. The SPC for TRT 2 and 3 was pre-hydrated with the water (1 protein: 1 water;w/w) prior to chopping. FSPC for TRT 4 was added to the chopper dry ie. not pre-hydrated. A portion of the SPC and all the water for TRT 5 and 6 was injected into the pork shoulder using a Koch P1-10 pickle injector. All TRT were formulated to 23+1.5% fat in batch sizes of 10kg/TRT. The meat, SPC (Procon 20/60 = SPCG, Textured Procon 7180 = TSPC, and PROMINE DS = FSPC), salt, cure, spices, and starter culture (Diversitech LP low temperature pediococcus) were added while chopping. The mixure was chopped to 3-5mm sized pieces and 10-11°C. then stuffed into 41mm clear fibrous casings, placed in the smokehouse (Drying Systems Co. Thermal Processing oven) smoked and dried per a typical Hungarian Dry Salami schedule (table 3).

Water activity (Aw) was measured daily in triplicate using a Decagon CX-1 water activity system. pH was also measured daily in triplicate using an Orion SA 250 pH meter. The percent fat, moisture and protein

Table 2--Formulations for Hungarian Style Dry Salami

	Treatment					
	1	2	3	4	5	6
Ingredients	All Meat	SPCG	TSPC	FSPC	sol/dry	SPCG dry
Pork Shoulder	95.900%	85.600	85.600	85.600	76.540	76.540
Pork Backfat	----	2.300	2.300	2.300	4.300	4.300
SPCG	----	4.000	----	----	----	2.40
TSPC	----	----	4.000	----	----	----
FSPC	----	----	----	4.000	4.000[2]	1.600[2]
Water	----	4.000	4.000	4.000	10.900	10.900
SAP[1]	----	----	----	----	0.160	0.160
Spices/Salt/ Cure	3.583	3.583	3.583	3.583	3.583	3.583
Starter Culture	0.517	0.517	0.517	0.517	0.517	0.517

[1]SAP - Sodium Acid Pyrophosphate

[2]1.6% FSPC, 10.9% water and 0.16% SAP solution injected into the pork shoulder. The rest of the FSPC (test 5) or SPCG (test 6) was added to the chopper dry.

Table 3--Smoke and dry schedule for Hungarian Style Dry Salami

Day	Dry Bulb	Wet Bulb	R. H.[1]	Smoke
1	22.0°C	20.5°C	93%	30 min
2	20.0	18.3	90	60
3	20.0	18.3	90	60
4	17.8	16.1	86	60
5	16.7	15.0	81	120
6-9	15.6	13.3	80	180
10-14	15.6	13.3	80	60

[1]R. H. - Relative Humidity was not measured. These are calculated values based on wet and dry bulb temperatures.

were measured in triplicate on day 0 (initial) 3, 6, 9, 12 and 14 per AOAC procedures (AOAC 1984). Yield (weight loss) was calculated for these same time frames. Dry salami texture was evaluated on day 14 by shearing a 2.5 cm core of salami with the Instron Universal testing machine. All data, except yield, was statistically analyzed using analysis of variance followed by Student-Newman-Keuls mean separation procedure (Snedecor et al 1967).

RESULTS

The Aw for the dry salami was not significantly different ($P < .05$) between TRT's on day 0 or 14 (table 4). As dry time increased, Aw decreased with final Aw on day 14 ranging from 0.92 to 0.90. The use of SPC in dry salami did not effect Aw initially nor after 14 days. This agrees with the work of (Ambrosiadis et al 1982)

where there was no difference in Aw after 28 days drying between all meat salami and salami containing textured soy protein.

The Hungarian dry salami smoke/dry schedule used was designed to yield salami with a finished pH of 4.6-4.8. Dry Salami pH after 14 days drying ranged from 4.6-4.7 (table 4). The use of SPC did not effect the final pH of Hungarian Style dry salami. Researchers using structured soy protein fiber (Joseph et al 1978), also found pH was not effected by the use of soy protein. These results conflict with the findings of (Ambrosiadis et al 1982, Modic et al 1978) where the use of soy protein lowered the pH compared to all meat salami. They attribute the lower pH to the higher carbohydrate content of soy protein. It is suspected that the soy protein used by (Ambrosiadis et al 1982, Modic et al 1978) was soy flour which has a higher carbohydrate content than SPC.

Table 4--Water Activity (Aw) and pH for Hungarian Style Dry Salami

Treatment	Aw		pH	
	Day 0	14	Day 0	14
All Meat	0.98^{a}	0.91^{b}	6.3^{a}	4.7^{c}
SPCG	0.98^{a}	0.92^{b}	6.2^{b}	4.7^{c}
TSPC	0.98^{a}	0.90^{b}	6.3^{a}	4.7^{c}
FSPC	0.98^{a}	0.90^{b}	6.3^{a}	4.6^{d}
FSPC sol/dry	0.99^{a}	0.92^{b}	6.3^{a}	4.6^{d}
FSPC sol/ SPCG dry	0.99^{a}	0.90^{b}	6.3^{a}	4.6^{d}

Means in the same column with the same letter are not significantly different ($P < .05$).

All TRT were formulated to 23±1.5% fat (table 5). As dry time increased, the percent fat also increased. TSPC dry salami and FSPC sol/SPCG dry had a significantly greater percent fat than the other dry salami tested on day 14. The amount of fat and the amount of moisture are inversely related. Therefore, it is logical that TSPC and FSPC sol/SPCG dry would have significantly ($P < .05$) less moisture day 14 than the other dry salami as shown in table 6.

The percent total protein and meat protein varied slightly throughout the study, with the percent of both meat and total protein increasing as dry time increased (table 7). By day 14, there was no significant difference between TRT, except SPCG had more total protein than the other TRT.

In the U.S.A. meat regulations require that dry fermented salami attain a moisture to meat protein ratio of 1.9:1 prior to packaging and sale. On day 12, all dry salami except TSPC met the required 1.9:1

Table 5--Percent fat for Hungarian Style Dry Salami

Treatment	Day				
	0	6	9	12	14
All Meat	22.01	29.39^{bc}	31.19^{b}	33.02^{ab}	34.45^{b}
SPCG	21.12	29.28^{bc}	30.75^{b}	29.70^{c}	31.42^{c}
TSPC	24.32	33.34^{a}	33.87^{a}	34.02^{ab}	37.62^{a}
FSPC	22.95	30.71^{b}	31.60^{b}	32.98^{ab}	33.80^{b}
FSPC sol/dry	21.74	28.42^{c}	30.29^{b}	31.90^{b}	32.48^{bc}
FSPC sol/SPCG dry	21.51	31.23^{b}	33.64^{a}	35.08^{a}	36.13^{a}

Statistical analysis was not done on day 0
Means in the same column with the same letter are not significantly different ($P < .05$)

Table 6--Percent moisture for Hungarian Style Dry Salami

Treatment	Day 0	6	9	12	14
All Meat	56.62	43.88[a]	41.88[a]	36.51[a]	36.59[a]
SPCG	57.39	45.05[a]	41.74[a]	36.48[a]	35.53[b]
TSPC	54.43	41.06[b]	40.38[a]	36.87[a]	32.70[a]
FSPC	53.22	44.51[a]	41.15[a]	37.94[a]	36.69[a]
FSPC sol/dry	55.70	44.66[a]	41.42[a]	37.73[a]	36.38[a]
FSPC sol/SPCG dry	56.04	42.88[a]	37.53[b]	34.81[b]	32.11[b]

Statistical analysis was not done on day 0
Means in the same column with the same letter are not significantly different ($P < .05$).

Table 7--Percent total protein and percent meat protein for Hungarian Style Dry Salami

Treatment	Day 6 TP	6 MP	9 TP	9 MP	12 TP	12 MP	14 TP	14 MP
All Meat	19.83[b]	19.83[a]	23.24[a]	23.24[a]	23.99[ab]	23.99[a]	23.86[b]	23.86[a]
SPCG	23.00[a]	20.28[a]	23.98[a]	21.26[ab]	25.20[a]	22.48[ab]	26.32[b]	23.60[a]
TSPC	20.67[ab]	17.65[a]	21.71[a]	18.99[a]	21.79[b]	19.07[c]	24.75[b]	22.03[b]
FSPC	22.39[ab]	19.67[a]	21.20[a]	18.48[b]	23.21[ab]	20.49[bc]	23.02[b]	20.30[b]
FSPC sol/dry	21.40[ab]	18.68[a]	22.06[a]	19.34[b]	22.72[ab]	20.00[bc]	23.84[b]	21.17[b]
FSPC sol/SPCG dry	21.39[ab]	18.67[a]	21.39[a]	18.67[b]	24.23[ab]	21.51[bc]	24.05[b]	21.33[b]

TP = total protein; MP = meat protein
Means in the same column with the same letter are not significantly different ($P < .05$).

moisture to meat protein ratio (table 8). However, all salami except FSPC would be ready for sale day 9 based on moisture to total protein. The replacement of meat with hydrated soy protein did not decrease the dry time based on moisture to meat protein ratio. Work by (Modic et al 1978, Modic 1979) indicated that dry sausage with textured soy protein can be sent to market one to two days earlier than all meat sausage. Preliminary work by Central Soya at an U.S.A. commercial meat company also indicated that dry salami with SPCG or TSPC was ready for market 5-7 days prior to the all meat salami. The drying times obtained in this study may perhaps have been influenced by the efficiency of the pilot scale smoking and drying equipment and the actual processing schedule used.

Instron shear force data from a 2.5 cm core of salami revealed no significant difference ($P < .05$) between TRT (table 9).

This data implies that the replacement of meat with hydrated SPC did not effect the firmness of the dry salami. Firmness measured by compressing dry salami (Ambrosiadis et al 1982) also

Table 8--Moisture to total protein and moisture to meat protein ratios for Hungarian Style Dry Salami

Treatment	Day 6 M/TP	6 M/MP	9 M/TP	9 M/MP	12 M/TP	12 M/MP	14 M/TP	14 M/MP
All Meat	2.22[a]	2.22[a]	1.81[a]	1.81[b]	1.52[ab]	1.52[b]	1.53[a]	1.53[b]
SPCG	1.95[a]	2.22[a]	1.74[a]	1.96[ab]	1.44[b]	1.62[b]	1.35[b]	1.50[b]
TSPC	1.99[a]	2.30[a]	1.86[a]	2.12[ab]	1.69[a]	1.94[a]	1.32[b]	1.49[b]
FSPC	1.99[a]	2.26[a]	1.94[a]	2.23[a]	1.63[a]	1.85[a]	1.59[a]	1.81[a]
FSPC sol/dry	2.09[a]	2.39[a]	1.88[a]	2.14[ab]	1.66[a]	1.89[a]	1.52[a]	1.72[a]
FSPC sol/SPCG dry	2.01[a]	2.31[a]	1.75[a]	2.01[ab]	1.43[b]	1.62[b]	1.33[b]	1.50[b]

M/TP = moisture/total protein; moisture/meat protein
Means in the same column with the same letter are not significantly different ($P < .05$)

Table 9--Instron sheer force for Hungarian Style Dry Salami

Treatment	Day 14 Sheer Force (kg)
All Meat	1.44[a]
SPCG	1.42[a]
TSPC	1.65[a]
FSPC	1.60[a]
FSPC sol/dry	1.33[a]
FSPC sol/SPCG dry	1.72[a]

Means with the same letter are not significantly different ($P < .05$).

showed no significant differences between all meat dry salami and dry salami containing textured soy protein.

CONCLUSION

The replacement of meat with 8% or 14.9% hydrated SPC did not adversely effect the quality of Hungarian style dry salami based on the data from this study. It was thought that the replacement of meat with hydrated SPC would decrease dry time as shown by (Modic et al 1978, Modic 1979) and unpublished Central Soya research at a commercial processor. The use of hydrated soy protein concentrate did reduce the cost per kg of Hungarian style dry salami (table 10). FSPC sol/dry and FSPC sol/SPCG dry were the least expensive salami to manufacture based on ingredient cost. The TRT using FSPC sol require additional equipment, namely a pickle injector, and due to the volume of water injected, tend to wrinkle during drying creating a visually unacceptable product. The best alternative based on the processing and appearance negatives of FSPC sol is the FSPC dry salami. Complete dispersion of dry FSPC is critical to avoid past problems of visable dry soy pockets in the salami.

Table 10--Cost analysis of Hungarian Style Dry Salami

Treatment	Raw Cost $/Kg	14 day Yield %	Finished Cost $/Kg
All Meat	1.44	61.80	2.33
SPCG	1.33	61.64	2.16
TSPC	1.34	64.05	2.09
FSPC	1.34	66.47	2.01
FSPC sol/dry	1.22	62.26	1.96
FSPC sol/SPCG dry	1.22	61.10	1.99

The ingredient cost for FSPC is $0.32/kg less than all meat and no additional equipment is required for manufacture. Further research needs to be done to determine the ideal smoke/dry cycle to maximize yields and minimize total dry time for dry salami with SPC, as well as the effect of SPC on organoleptic and microbiological properties of Hungarian Style Dry Salami.

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