Partial and Total Replacement of Meat by Plant-based Protein in Pork Sausage

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1. Background

The meat industry is a large factor of global warming. A plant-based protein with the use of soy is rising in popularity. However, soy is one of the top allergens. Pea has been attracting attention in recent years as a plant protein with a high amino acid score and a low risk of allergies.

2. Objective

Pea protein (PP) is difficult to be texturized due to its lower gelling capacity and has a distinct odor and texture. The effect of the ratio of PP to meat on the physical properties of sausages will be experimentally clarified, and the possibility of PP in meat substitution was examined.

3. Materials and Method

Processing: Four types of sausages (Table 1) were prepared with PP (80% protein), ground pork (over 85% red meat) and spices (smoked paprika seasoning, Italian herbal mix), tomato paste, dried shiitake, olive oil, collagen casing (animal products used). Moisture content of materials was measured by drying and the water content of PP was matched to the same value (67%). Commercial plant-based analogues were measured for comparison as well.

Measurements: The hardness and Warner–Bratzler Shear Force (WBSF) were measured using the texture analyzer (Shimadzu) of steamed sausages. Expansion ratio during steaming was measured by observing change in height and weight. Color measurement was performed using a colorimeter (Minolta).

4. Results and Discussion

As shown in table 1, it was found that as the ratio of PP in the sausages increased, the hardness and WBSF decreased as the plant-based sausages were better at keeping in the fat and water during the steaming process. Highest value of both hardness and WBSF was found in sample PP:Pork of 20:80. Hardness values increased 10.4 N to 19.1 N and 28.2 N in samples 100:0, 50:50 and 20:80, respectively and decreased to 25.3 N in sample 0:100. These results are similar to a study done by Feng and Xiong (2002) in which it was found that in soy and myofibrillar proteins result in a less stable confirmation as soy protein isolate will interfere in making gel-network in meat emulsion. WBSF values increased 4.1 N to 6.1N and 12.5N in sample 100:0, 50:50 and 20:80, respectively and decreased to 9.4 N in sample 0:100.

It was found an overall trend can be seen with decrease in PP, there was an overall increase in lightness (L*) and decrease in redness (a*) and yellowness (b*). The highest value of lightness (L*) was found in sample 0:100 which was 56.3. Highest value of redness and yellowness was found in sample 100:0 at 5.7 and 33.2 and sample 50:50 at 5.2 and 33.5, respectively.

Among all the samples, the Tofurky had the lowest value for lightness at 42.7 and highest value of redness at 6.5 and among the commercial products had highest values of mechanical forces at 18.9 N for hardness and 15.4 N for WBSF (Table 1). Plant based samples had similar mechanical property values as commercial products were closest to samples 100:0 and 50:50.

Table 1 The mean (±SD) of color measurement, hardness and WBSF for subjected sausages

Sample (PP: Pork) (wt%)	L*	a*	b*	Hardness (N)	WBSF (N)
100:0	48.7±1.3	5.7±0.6	33.2±0.9	10.4±1.0	4.1±0.6
50:50	53.7±1.7	5.2±0.5	33.5±1.5	19.1±2.7	6.1±1.4
20:80	54.1±1	3.9±0.8	19.9±1.6	28.2±2.4	12.5±0.9
0:100	56.3±1.4	3±0.3	20.4±1	25.3±1.7	9.4±1.0
Tofurkey*	42.7±1.5	6.5±0.5	28.3±0.4	18.9±1.8	15.4±0.3
Lightlife*	60.1±1.5	10.1±0.5	35.7±1.1	10.7±1.0	10.0±0.7
Trader Joe's*	51.5±0.6	2±0.6	21.5±0.4	10.7±0.4	11.4±0.9

*Commercial Products (Soy based sausages)

5. Future Plan

Results are promising in the usage of PP of replacing meat in sausages. However, much work is need to improve the sensory properties of the taste, odor and texture of the sausage as well as the final goal of developing full plant-based sausage as this study was focused primarily on clarifying the effect of the ratio of PP to meat. Usage of wheat gluten or PP isolate powder as the main binding agent in order to form a fibrous texture similar to meat as well as starch, oil and water ratio should be further investigated to improve the physical properties.