51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

EFFECTS OF MEAT TYPES AND FAT SUBSTITUES ON COLOR AND TEXTURAL OF LOW FAT SAUSAGE

Han-Sul Yang*, Sung-Gil Choi, Seon-Tea Joo and Gu-Boo Park

* *Division of Applied Life Science, Graduate School, Gyeongsang National University, Jinju, Gyeongnam 660-701, Korea*

Key Words: low fat sausage, meat types, fat substitutes, water binding capacity

Introduction

Due to concerns with obesity and related diseases, consumers are looking for no fat or low fat meat products. With excessive fat reduction, however, the low fat meat products have hard texture, lack of meat flavor and dark color, resulting in less acceptable to consumers. Fat substitutes based on proteins and carbohydrates have been widely used in meat industry to overcome the problems. The physical and structural properties of ingredients are strongly dependent on molecular interactions with water. Oat and soy protein have shown promise for increasing yield and juice retention in meat (Claus and Hunt, 1991; Lecomte et al., 1993). In addition, the constituents have been used in diets to control hypertension, diabetes, and health disease. However, there is little information on why the additions of oatmeal or tofu induce the change in textural attributes and/or water retention properties of low fat sausages.

Objectives

The objectives of this research were to evaluate the color and textural properties of low fat sausages by addition of oatmeal and tofu, to compare the effectiveness of incorporated oatmeal and tofu on sausages prepared with different types of meats such as beef, pork, and chicken, and to investigate the relationship between water binding properties of fat substitutes and changes in textural properties of low fat sausages.

Methodology

Sausage preparation : Beef, pork, and chicken were purchased from a local market and trimmed to reduce fat content before grinding though a 3mm plate. The moisture content meats, oatmeal, and, tofu were adjusted to 60%. This was done to ensure that any differences observed for added oatmeal and tofu would not be biased by differing moisture content. 10% hydrated oatmeal and tofu were added to each meat in a basis of total weight. The control sausages were also prepared without addition of oatmeal or tofu. For each batch, meat, oatmeal or tofu other ingredient were mixed throughly using mixer. After mixing, the mixture was stuffed into artificial cellulose casing with diameter of about 30mm using a stuffer. The sausages were then held for 24hrs at 4℃ to allow for ingredient equilibrium. The sausage samples were cooked for 30min in a steam chamber (SAA10, Absury, Germany) until the center temperature of the sausage reached of 70℃.

Moisture absorption isotherm (%) : Meats, oatmeal, and tofu were dried for 3days using freezing dryer, after freezing them at -80℃ (clean vac 8, Biotron, Korea). Samples (approximately 1g each) were put into polystyrene weighting dishes (2× 2 inches, Fisher Scientific Co) and further dehydrated in a vacuum desiccator over P_2O_5 for 5-7 days until a content weight was attained. The dehydrated samples were equilibrated at 25℃ in sealed chambers over various saturated salt solutions with known relative vapor pressures (RVP): P_2O_5 (0), LiCl (0.11), KCH_3 (0.23), $MgCl_2$ (0.33), K_2CO_3 (0.43), $Mg(NO_3)_2$ (0.53), KI (0.69), $(NH_4)_2SO_4$ (0.81) and KNO_3 (0.93). Equilibrium moisture content (% db) was calculated from the weight gain after no further change in weight occurred. The triplicate samples from each treatment were measured.

Color : The color of the sausage samples was evaluated with CIE L^* (lightness), a^* (redness) and b^* (yellowness) values using a Minolta chromameter (CR-310, Minolta Co. LTD. Japan). The measurement was done triplicated.

TPA (texture profile analysis) : Before analysis, cooked sausages were equilibrated at room temperature (20℃) for l hr. Sausages were cored into a cylinder with 1 cm diameter and cut with 1.5 cm height using a sharp edged knife. TPA was performed by compressing the sample between parallel plates in a Universal Testing Machine (Model 3343) to 70% of the original height in two consecutive cycles at a crosshead speed 100mm/min. From the resulting force/deformation curves, the textural parameter of hardness, cohesiveness, springiness, brittleness, gummness, and chewiness were calculated. 10 specimens of each treatment were measured and analyzed statistically.

Statistical analysis : The data were analyzed using statistical analysis systems (SAS. 1999). To evaluate the differences among treatments, data were analyzed by analysis of variance (ANOVA) and Duncun's multiple range test.

Results & Discussion

The color of sausage samples with or without oatmeal and tofu is shown in table 1. Beef sausage showed higher lightness (L^*) and lower redness (a^*) values compared to chicken or pork sausage ($P<0.05$). However, as additions of oatmeal and tofu, the L^* value increased but a^* value decreased significantly ($P<0.05$). Data showed that addition of tofu was more effective to increase L^* values and to decrease a^* values of all meat sausages compared with addition of oatmeal. Table 2 shows TPA of the sausages with different types of meats and with/without oatmeal and tofu. As expected, beef sausage had a higher hardness compared to chicken and pork sausages, and the hardness of sausage samples decreased by additions of oatmeal and tofu. Results suggested that higher values in brittleness, hardness, gummness and chewiness of sausages from all meats could decrease significantly by additions of oatmeal and tofu. The sausage sample added with oatmeal gave softer (less brittleness, hardness) and higher springiness, compared to control and tofu added sausages. These results may be due to the difference in water binding properties among meats, oatmeal, and tofu.

Fig. 1 shows moisture absorption isotherms at 25 for freeze-dried powders from all meats, oatmeal and tofu of uncooked samples. All samples showed increase in moisture absorption as increase of a_w values from 0.11 to 0.93. The moisture absorption of oatmeal was higher than those of others by a_w 0.53, however, oatmeal showed significantly lower moisture absorption above a_w 0.53. The moisture absorption of oatmeal was approximately 28% at a_w 0.93 whereas those of others were above 45%. However, the moisture absorption isotherms of cooked samples showed a considerable different from uncooked samples (Fig. 2). Oatmeal showed higher moisture absorption % by a_w 0.69 compared to all meats and tofu. Moreover, at a_w 0.93, the moisture absorption of oatmeal was approximately 27% which was almost similar to uncooked sample, whereas that of tofu was approximately 22% which was almost half of uncooked sample. These results imply that the moisture absorption of tofu depends on condition of proteins that be denatured or not by heating. Therefore, it could be possible that the soft and tensile texture of sausage with addition of oatmeal compared to tofu (Table 2) was due to better water absorption capacity of oatmeal under cooking condition. In addition the result may imply that decreasing of hardness of sausage with addition of tofu might be due to soft textural property of tofu itself rather than increase in water binding capacity of tofu moisture absorption. Data suggested that addition of oatmeal would be more effective than tofu to improve texture of a low fat sausage because proteins in tofu could be denaturated by cooking resulted in a poor water-binding capacity.

Conclusions

Color and textural properties of a low fat sausage could be improved by addition of oatmeal and tofu as a fat substitute. Addition of oatmeal and tofu increased lightness and tenderness of a low fat sausage. Moisture absorption of tofu was dependant on denaturation of proteins by heating while that of oatmeal was not changed by cooking. It was suggested that addition of oatmeal would be more effective than tofu to improve texture of a low fat sausage.

References

Chang, H.C. and Carpenter, J.A. 1997. Optimizing quality of frankfurters containing oat bran and adder water. J. Food Sci. 62:194–197.

Claus, J.R. and Hunt, M.C. 1991. Low-fat, high added-water bologna formulated with texture-modifying ingredients. J. Food Sci. 56(3):643–652.

Pouttu, P. and Puolanne, E. 2004. A procedure to determine the water-binding capacity of meat trimmings for cooked sausage formulation. Meat Sci. 66:329–224.

Tables and Figures

Table 1. Color in low fat sausages with or without oatmeal and tofu

Treatments	L^*	a^*	b^*
*Beef	49.86^{H}	19.19^{A}	9.56^{C}
*Pork	64.86^{E}	14.48^{C}	8.01^{E}
*Chicken	73.73^{B}	8.43^{E}	11.21^{AB}
Beef + 10% hydrated oatmeal	50.54^{G}	17.11^{B}	9.09^{D}
Pork + 10% hydrated oatmeal	66.68^{D}	12.57^{D}	9.90^{C}
Chicken + 10% hydrated oatmeal	74.91^{A}	6.54^{F}	11.51^{A}
Beef + 10% tofu	53.23^{F}	12.57^{D}	10.98^{B}
Pork + 10% tofu	70.66^{C}	11.53^{D}	7.59^{E}
Chicken + 10% tofu	73.99^{B}	7.81^{EF}	10.71^{B}

- ^{A,B,C,D,E,F} : Means in the same column with identical letters are significantly different ($p < 0.05$).
- * : Control; without oatmeal and tofu.

Table 2. TPA (texture profile analysis) in low fat sausages with or without oatmeal and tofu

Treatments	Brittleness (kgf)	Hardness (kgf)	Cohesiveness (%)	Springiness (mm)	Gummness (kg)	Chewiness (kg*mm)
*Beef	0.47^{A}	0.63^{A}	56.79^{B}	14.00^{C}	35.64^{A}	498.66^{A}
*Pork	0.36^{B}	0.51^{B}	55.96^{B}	14.17^{BC}	28.59^{B}	406.77^{B}
*Chicken	0.36^{B}	0.40^{C}	49.69^{C}	13.99^{C}	20.09^{C}	281.09^{C}
Beef + 10% hydrated oatmeal	0.25^{DE}	0.31^{FG}	48.87^{C}	14.11^{BC}	15.33^{D}	219.29^{E}
Pork + 10% hydrated oatmeal	0.22^{EF}	0.28^{GH}	55.96^{AB}	14.17^{AB}	16.29^{D}	234.58^{DE}
Chicken + 10% hydrated oatmeal	0.18^{F}	0.27^{H}	61.77^{A}	14.52^{A}	16.05^{D}	233.04^{DE}
Beef + 10% tofu	0.31^{C}	0.39^{CD}	50.67^{C}	13.66^{D}	19.58^{C}	266.31^{DE}
Pork + 10% tofu	0.28^{CD}	0.36^{DE}	58.68^{AB}	12.99^{E}	20.82^{C}	270.18^{C}
Chicken + 10% tofu	0.26^{DE}	0.32^{EF}	48.35^{C}	14.26^{ABC}	15.52^{D}	220.93^{E}

- ^{A,B,C,D,E,F,G,H} : Means in the same column with identical letters are significantly different ($p < 0.05$).
- *: Control; without oatmeal and tofu.

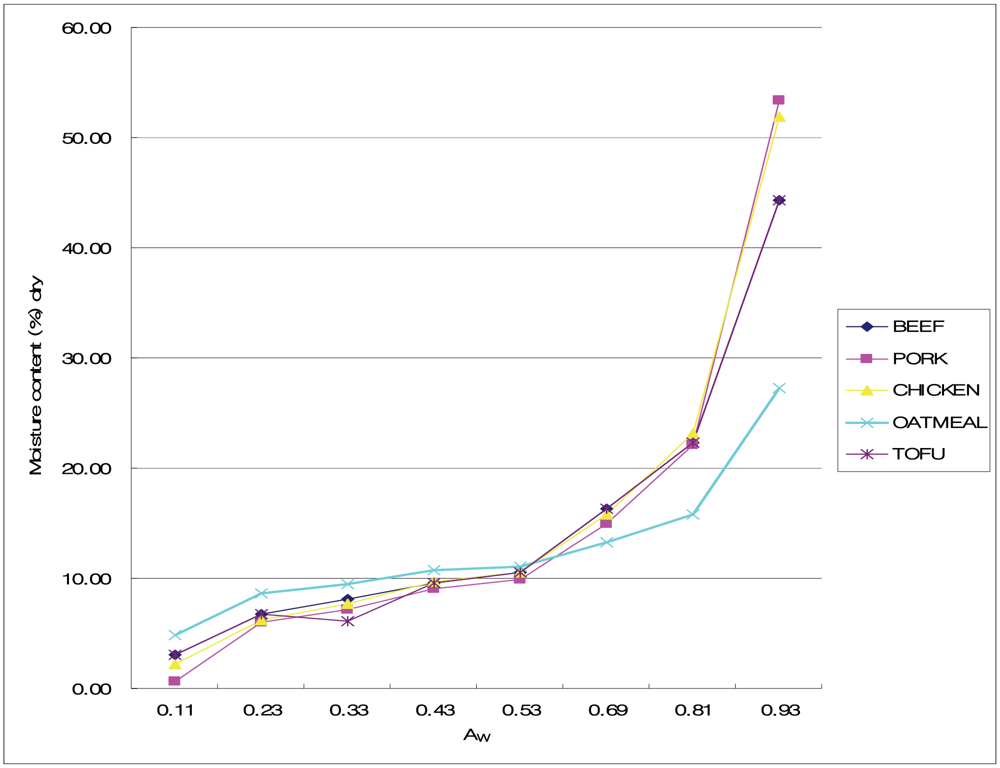

Figure 1. Moisture adsorption isotherm in meat types, oatmeal and tofu of raw powder samples.

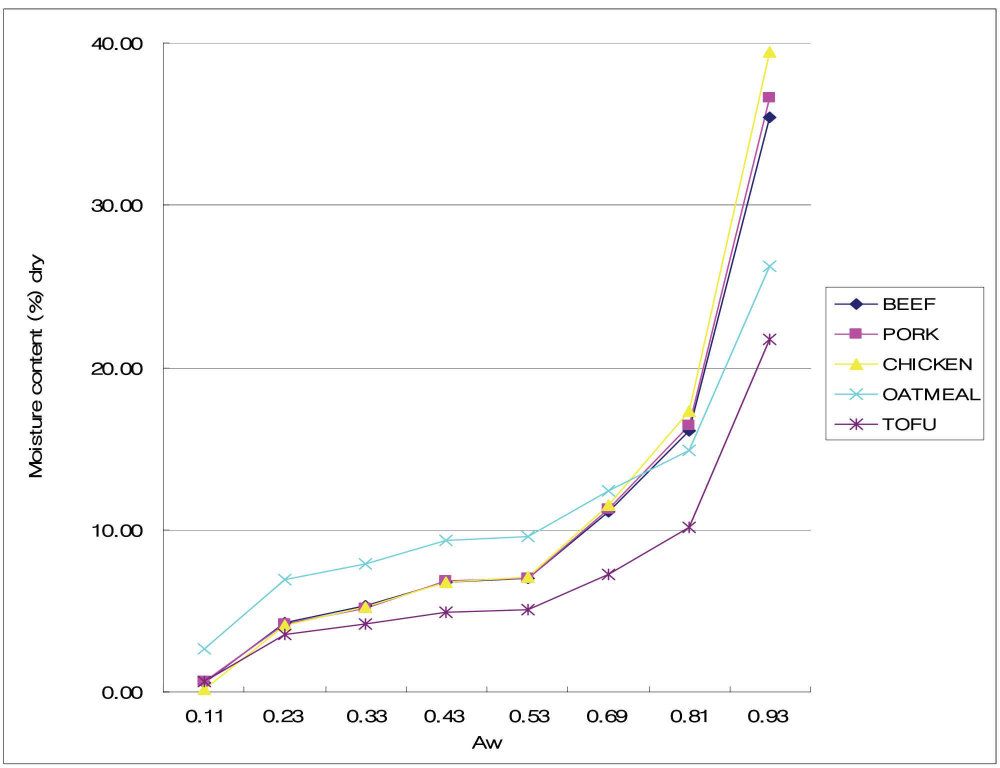

Figure 2. Moisture adsorption isotherm in meat types, oatmeal and tofu of cooked powder samples.