Properties of low fat sausages made from duck meat with cereal flours

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Abstract

Sausages were produced using duck meat, supplemented with 10% beef fat (FDS) and 10% hydrated cereal flours including rice (RDS), wheat (WDS), corn (CDS), millet (MDS) and barley (BDS). Duck sausage (DS) were also made without any cereal flours or fat. Protein and fat contents significantly decreased and total expressible fluid reduced with the addition of cereal flours in duck sausage batters. FDS had higher fat content and lower pH compared to others. WDS showed the lowest cooking loss among sausages and had similar redness and chroma values with FDS and DS. Hardness of duck sausage was significantly decreased on addition of cereal flours and beef fat. RDS showed the lowest values for all texture measurements. Result of moisture absorption capacity suggested that the decrease in hardness of RDS was due to the higher-retention properties of rice flour. Sensory evaluation indicated that DS had significantly lower overall acceptability, due to its off-flavor, while RDS had higher overall acceptability.

Introduction

Particular attention has focused on health problems associated with fat content in food, and consumers are looking for no fat or low fat meat products. With excessive fat reduction, however, the products' desired flavor and texture can be affected, resulting in decreased demand by consumers. In recent years, cereals and its ingredients have been accepted as functional foods, primarily due to constant promotion of dietary fiber, proteins, energy, minerals, vitamins and antioxidants required for human health. Although, all segments of the meat industry are attempting to market low-fat products, the beef, pork and poultry industries offer a wider variety of products. Sausages made from beef and pork are available in the market, while studies on sausages made from chicken have also been conducted by many researchers. However, duck meat products do not receive enough attention by researchers. Duck is still very popular and in strong demand in many areas of the world, especially in Asia. As such, the aim of the present study was to investigate how the quality and textural properties of low fat sausages made from duck meat were affected by addition of different cereal flours, and in the process identify a commercially desirable cereal supplement.

Materials and methods

Duck meat and cereal flours including rice, wheat and corn were purchased from a local market and stored in a cold room at 4 ºC. Millet and barley were purchased grain and grounded to flour in a grinding mill. Moisture content of all cereal flours were adjusted to 73%, in order to match the moisture content of the duck meat. Sausage batches were prepared in a cold room at 4 ºC, and duck meat were supplemented with 10% (w/w) rice flour (RDS), wheat flour (WDS), corn flour (CDS), millet flour (MDS) and barley flour (BDS). Two control sausages were also prepared using only duck meat (DS) and 10% (w/w) beef fat (FDS). For each batch of sausage, other ingredients were mixed, homogenized, and stuffed into synthetic cellulose casings. Samples were cooked for 30 min at 80 ºC in a steam chamber until the center temperature of the sausages reached 70 ºC.

Proximate composition analysis of cereal flour and sausage batters was performed according to AOAC methods (AOAC, 2000). The surface color (CIE L^*, a^*, b^*) of sausage samples were measured using a Minolta Chromameter. The total expressible fluid (TEF) was measured with twenty-five grams of raw emulsion by centrifugation. The volumes of TFE were calculated as follows: TEF = (weight of centrifuge tube and sample) - (weight of centrifuge tube and pellet). For cooking loss, weights of uncooked and cooked sausages were recorded, and the cooking yield was calculated as follows: Cooking loss (%) = cooked weight / uncooked weight × 100. Texture profile analysis (TPA) was performed in an Instron Universal Testing Machine to measure hardness, cohesiveness, springiness, gumminess and chewiness. Water adsorption capacity (WAC) measurements were conducted using hydrated flours following procedures described by Yang et al. (2007). A sensory panel (at least 20 untrained) consisting of students, faculty, and staff of the Gyeongsang National University was used to evaluate sensory characteristics, such as appearance, color, flavor, off-flavor, hardness,

juiciness and overall acceptability using a 9-point hedonic scale. The data were analyzed by analysis of variance (ANOVA) using Statistical Analysis System (SAS) program.

Results and discussion

Moisture content was higher in rice and wheat flour, while lower in corn and barley flour. The lowest protein content was found in corn flour. Fat content was significantly higher in corn flour and lower in wheat flour. The BDS batter showed significantly lower moisture content than other batters, and protein was significantly lower in batters with added cereal flours, except for barley when compared with DS or BDS batters. Fat content was significantly higher in BDS batter and lower in all sausage batters with added cereal flours. There was no significant difference in fat content between DS and sausage batters with added cereal flours. TEF was significantly increased with addition of beef fat, but decreased with addition of cereal flours. This indicated that emulsion activity of duck sausage batter decreased by addition of cereal flours, and it was influenced by fat content. BDS batter showed that higher fat content was associated with higher emulsion activity, while sausage batters showed that lower fat content, induced by addition of cereal flours, had lower emulsion activity. The pH of sausage batters increased with addition of cereal flours, but decreased with addition of beef fat. However, apart from WDS batter, cooking loss was not significantly different among sausage batters. These results suggest that while emulsion activity could be decreased, increasing pH prohibits the reduction of added cereal flours. The L^* values of WDS, MDS and BDS were significantly lower compared to DS or FDS. Also, apart from wheat, a^* values of duck sausages with added cereal flours were significantly lower than those of DS and FDS. These results indicate that addition of cereal flours reduce the redness of duck sausage.

As expected, highest hardness value was found in DS, proving that the addition of beef fat or cereal flours significantly reduced hardness. Apart from corn flour, the addition of cereal flours achieved higher reduction value compared with beef fat. No significant difference in hardness was found between CDS and FDS. Similar to hardness, DS had significantly higher gumminess and chewiness compared to sausages with added beef fat or cereal flours, while RDS and BDS exhibited significantly lower gumminess and chewiness. Here, it appears that increased softness achieved with added cereal flours is related to their higher water absorption capacity after heat treatment. Equilibrium moisture content was lower in corn flour compare to other flours (Data not shown). This indicates that corn flour achieves the least softness in sausage. Sensory evaluation indicates that MDS had significantly better color, and it may be related with lower yellowness and chroma values. No significant differences were found in flavor of all sausages, but significantly higher off-flavor was observed by the panel in DS. Tenderness of DS was significantly lower than those of RDS and MDS. Consequently, overall acceptability of RDS was significantly higher than DS. The higher acceptability of RDS may be related with enhanced tenderness and higher preference of rice, by Asians, than other cereals. It could be possible that the higher acceptance of duck sausage with added rice flour may be related with the feeding habit of the study region. Our results suggest that low-fat duck sausage, which is highly acceptable in Asia, could be made by addition of rice flour.

Table 1. Proximate composition (%), total emulsion fluid (TEF, %), pH and cooking loss (%) of duck sausage batters with added cereal flours

Sausages*	Moisture	Protein	Fat	Ash	TEF	pH	Cooking loss
DS	72.1^{a}	16.7^{a}	6.8^{b}	2.8^{a}	5.28^{b}	6.61^{d}	5.51^{a}
FDS	67.8^{b}	16.4^{ab}	19.3^{a}	2.9^{a}	5.77^{a}	6.58^{e}	5.51^{a}
RDS	71.6^{a}	14.6^{c}	5.3^{c}	2.5^{ab}	1.97^{c}	6.66^{a}	5.19^{ab}
WDS	72.0^{a}	14.3^{c}	4.7^{c}	2.5^{ab}	1.63^{cd}	6.64^{b}	4.08^{b}
CDS	71.8^{a}	12.9^{d}	5.9^{bc}	2.3^{b}	1.32^{d}	6.66^{a}	5.55^{a}
MDS	72.0^{a}	14.4^{c}	5.3^{c}	2.9^{a}	1.73^{cd}	6.62^{c}	5.56^{a}
BDS	72.0^{a}	15.6^{b}	5.0^{c}	2.5^{ab}	1.88^{c}	6.62^{cd}	5.12^{ab}

* DS refers to duck sausage, and FDS, RDS, WDS, CDS, MDS and BDS refer to duck sausages with 10% supplemented beef fat, rice flour, wheat flour, corn flour, millet flour and barley flour, respectively.

[a-c] Means with different superscripts within a column differ significantly ($p < 0.05$).

Table 2. Color and textural measurements of duck meat sausages with added cereal flours

Sausages*	L^*	a^*	b^*	Hard-ness(N)	Cohesive-ness (%)	Springi-ness(mm)	Gummi-ness (N)	Chewiness (N*mm)
DS	58.6^{a}	15.8^{a}	8.7^{b}	3.92^{a}	56.7^{a}	12.9	222.5^{a}	2879.0^{a}
FDS	58.6^{a}	15.9^{a}	9.2^{a}	3.14^{b}	55.5^{ab}	13.0	173.1^{b}	2253.3^{b}
RDS	58.3^{a}	15.5^{b}	8.9^{b}	1.86^{c}	47.2^{d}	13.7	86.7^{d}	1193.1^{d}
WDS	56.7^{b}	15.6^{ab}	9.0^{ab}	2.2^{c}	51.7^{c}	13.7	117.3^{c}	1612.7^{c}
CDS	58.6^{a}	14.4^{c}	8.1^{c}	3.3^{b}	52.3^{bc}	13.1	169.7^{b}	2236.4^{b}
MDS	56.3^{b}	13.3^{d}	7.8^{d}	2.2^{c}	47.7^{d}	13.6	108.0^{c}	1468.2^{cd}
BDS	55.9^{b}	13.7^{d}	9.2^{a}	2.0^{c}	48.1^{d}	13.1	99.8^{cd}	1312.8^{d}

$^{a-d}$ Means with different superscripts within a column differ significantly ($p < 0.05$).

Table 3. Sensory evaluation of duck meat sausages with added cereal flours

Sausages*	Color	Flavor	Off-flavor	Juiciness	Tenderness	Overall acceptability
DS	5.2^{bcd}	4.4	3.5^{a}	3.9	3.7^{b}	3.8^{b}
FDS	4.6^{d}	4.2	2.4^{ab}	4.2	4.5^{ab}	4.6^{ab}
RDS	5.2^{bcd}	4.8	1.8^{b}	4.6	5.5^{a}	5.3^{a}
WDS	5.6^{bc}	4.6	1.9^{b}	4.1	5.2^{ab}	4.8^{ab}
CDS	5.1^{cd}	4.9	1.8^{b}	4.4	4.6^{ab}	4.8^{ab}
MDS	6.8^{a}	4.6	1.9^{b}	4.4	5.5^{a}	4.3^{ab}
BDS	5.8^{b}	4.5	1.9^{b}	4.5	5.1^{ab}	5.0^{ab}

$^{a-d}$ Means with different superscripts within a column differ significantly ($p < 0.05$).

Conclusions

Fat and protein contents of duck sausage were reduced by addition of various cereal flours. Addition of cereal flours also reduced hardness, cohesiveness, gumminess and chewiness of sausages, with highest reduction values being attributed to the addition of rice flour. Sensory evaluations indicated that acceptability of duck sausages could be enhanced by addition of cereal flours. In particular, the addition of rice flour increased overall acceptability with improvement of texture attributes. This study demonstrates that a desirable low-fat duck sausage can be produced if 10% of meat content is replaced with cereal flours, thereby reducing the off-flavor associated with pure duck meat. Among the cereal flours, rice flour was shown to be the most desirable.