Development of Chicken Sausage using Combination of Wheat Bran with Dried Apple Pomace or Dried Carrot Pomace

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ABSTRACT
Present study was conducted to develop chicken sausage by incorporating wheat bran (WB) in combination with dried apple pomace (DAP) or dried carrot pomace (DCP). Treatments consisted of addition of 2% WB+ 2% DAP/2% DCP, 2% WB+ 4% DAP/4% DCP, 2% WB+ 6% DAP/6% DCP, 2% WB+ 8% DAP/8% DCP respectively by replacing lean meat. Casings filled with raw emulsion were cooked in a closed container for 30 minutes to prepare chicken sausages. Cooked sausages were subjected to sensory, texture profile and instrumental colour analysis. A gradual decrease in sensory scores was observed with increase in fibre level. Hardness and shear press value increased while springiness and cohesiveness decreased with increase in fibre level. A steady increase in gumminess and chewiness of WB + DCP added sausage was also noticed with increase in fibre level. Increase in DAP level in WB + DAP treated sausage produced darker sausage with higher redness scores while DCP increase resulted in lower redness and higher yellowness scores of WB + DCP sausage. It is concluded that chicken sausage with very good sensory acceptability can be prepared using a combination of wheat bran (2%) with dried apple pomace (4%) or dried carrot pomace (4%) each.

Key words: Chicken sausage, Pomace, Sensory evaluation, Wheat bran.

INTRODUCTION
Meat is a very good source of high quantity and quality of proteins and is known for its satiating characteristics. It is also an excellent source of minerals and vitamins. Some nutrients like iron, vitamin B₁₂, and folic acid are either absent or have lesser bioavailability in foods other than meat (Arihara, 2006; Biesalski, 2005). Unfortunately, meat is deficient in dietary fibre. Past researches carried out in this aspect have explained a relationship between dietary fibre deficient diet and an increase in number of health issues like obesity, cancer and cardiovascular diseases (WHO/FAO, 2003). With rising consumer alertness about the correlation between diet and health, the emphasis now a days is on the development of functional foods. Significance of dietary fibre in human diet has been well established. The processing of meat products by incorporating dietary fibre leads to the generation of functional meat products that are beneficial to human health.

Wheat bran is a by-product obtained during milling and is a concentrated source of dietary fibre. It is composed of approximately 47.6% dietary fibre of which 96% is insoluble (Cho et al., 2004).

For development of fibre enriched meat products in the past, dietary fibres from cereals were used more often than fruit or vegetable fibres. As producers are persistently searching for inexpensive ingredients with extra value, the byproducts of fruit and vegetable processing offers a potential solution. Fruits and vegetable byproducts are a valuable source of dietary fibre. Using these byproducts in dehydrated form adds to their total dietary fibre content and decreases the bulk due to loss of moisture.

Apple pomace is the remnant which remains after apple juice extraction and is a byproduct of the apple juice industry. It is rich in nutrients like carbohydrate, pectin, crude fibre and minerals (Shalini and Gupta, 2010). Chemical composition of apple pomace indicates that it is not only a superior source of TDF but also comprises of higher soluble dietary fibre fraction consisting of pectin (Shah and Masoodi, 1994). Carrot is generally used for juice production and large amount of carrot pomace is obtained after juice extraction. Although it contains a lot of phytochemicals, it is usually disposed as feed. The pomace can be used as an appropriate constituent in processed food. Hence, carrot pomace can be used as an appropriate constituent in processed food.

No scientific information is available on the combined use of wheat bran with apple pomace or carrot pomace in chicken sausage. Therefore, this investigation was carried out to study the combined effect of wheat bran (WB) with dried apple pomace (DAP) or dried carrot pomace (DCP) on quality characteristics of chicken sausages.
**MATERIALS AND METHODS**

Procurement and processing of dietary fibre sources

Wheat bran, apple and carrot were purchased from nearby market. Pomace of apple and carrot were obtained after extraction of juice. Wheat bran and both types of pomace were separately dried, ground, packaged in air tight container and stored under frozen conditions (Yadav et al., 2016; 2018).

Preparation of chicken sausage

Meat was manually deboned and minced in an electrical mincer with 4 mm plate. Additives like sodium chloride, spice mix, condiments paste, sodium nitrite, sodium tripolyphosphate (STPP), refined wheat flour, groundnut oil and water were added to minced meat in suitable proportion (Table 1) for the manufacturing of control meat emulsion.

Treatments of wheat bran (WB) and dried apple pomace (DAP) consisted of addition of 2% WB + 2% DAP (WAS-2), 2% WB + 4% DAP (WAS-4), 2% WB + 6% DAP (WAS-6), 2% WB + 8% DAP (WAS-8) respectively by replacing lean meat. Treatments of WB and dried carrot pomace (DCP) consisted of addition of 2% WB + 2% DCP (WCS-2), 2% WB + 4% DCP (WCS-4), 2% WB + 6% DCP (WCS-6), 2% WB + 8% DCP (WCS-8) respectively by replacing lean meat (Table 1). The additives other than dietary fibre sources were used in same concentration as in control. A fine meat emulsion was prepared by mixing minced chicken meat and other ingredients (including dietary fibres) in a bowl chopper for 4 to 6 minutes. The stable emulsion so prepared was filled uniformly in cellulose casings (C-25×70 ft.) by a hand-operated sausage filler and linked by a thread at uniform intervals. Casings filled with raw emulsion were cooked in a closed container for 30 minutes to prepare chicken sausages. Cooked sausages were dethreaded, allowed to cool up to room temperature and subjected to sensory, texture profile and instrumental colour analysis.

**Sensory evaluation**

A semi-trained panel comprising of ten members was used for the assessment of sensory quality of sausages. Sensory characteristics (colour and appearance, flavour, texture, tenderness, juiciness and overall acceptability) were analyzed using 8-point descriptive scale where score 8 and 1 indicated extremely desirable and extremely undesirable respectively.

**Texture profile analysis**

The texture profile of cooked chicken sausage was analyzed using TAHD Plus Texture Analyser (Stable Micro Systems, England) by following the method given by Bourne (1978). Samples of 20 mm diameter and 15 mm height were compressed (by 70 mm compression plate, 50 kg load cell and the test speed of 2mm/s) to 50% of their initial height. Between two compression cycles, 5 sec time interval was given to obtain force time deformation curves.

**Shear press value**

Warner Bratzler shear probe of texture analyser was used to determine shear press value. Force needed to shear a sausage sample of 20 mm diameter transversely was expressed in Newton (N).

**Instrumental colour analysis**

The colour scores were measured as CIE Lab, L* (lightness), a* (redness) and b* (yellowness) using a chroma meter (Konica Minolta Sensing, Inc., Japan) with 8 mm orifice for measurement. The equipment was standardized with a white standard plate before measurement.

**Statistical analysis**

The data obtained were evaluated by analysis of variance. To find out the significant differences in means, Duncan’s multiple range test was used. Critical difference was determined at 5% level of significance (Snedecor and Cochran, 1980).

**Table 1:** Composition of meat emulsion for preparation of chicken sausage.

| Ingredients          | Control | WAS-2/ WCS-2 | WAS-4/ WCS-4 | WAS-6/ WCS-6 | WAS-8/ WCS-8 |
|----------------------|---------|---------------|---------------|---------------|---------------|
| Meat                 | 79.2    | 75.2          | 73.2          | 71.2          | 69.2          |
| STPP                 | 0.3     | 0.3           | 0.3           | 0.3           | 0.3           |
| Common salt          | 1.6     | 1.6           | 1.6           | 1.6           | 1.6           |
| Spice mix            | 1.9     | 1.9           | 1.9           | 1.9           | 1.9           |
| Condiments (Onion : Garlic) 2:1 | 3       | 3             | 3             | 3             | 3             |
| Oil                  | 4       | 4             | 4             | 4             | 4             |
| Water                | 8       | 8             | 8             | 8             | 8             |
| Sodium nitrite       | 0.015   | 0.015         | 0.015         | 0.015         | 0.015         |
| Refined wheat flour  | 2       | 2             | 2             | 2             | 2             |
| Water                | 0       | 2             | 2             | 2             | 2             |
| Sodium nitrite       | 2       | 4             | 4             | 6             | 8             |

* DAP (dried apple pomace) was added in WAS treatments and DCP (dried carrot pomace) was added in WCS treatments respectively.

WAS-2, WAS-4, WAS-6, WAS-8: chicken sausage incorporated with 2% wheat bran and 2% dried apple pomace, 2% wheat bran and 4% dried apple pomace, 2% wheat bran and 6% dried apple pomace, 2% wheat bran and 8% dried apple pomace respectively.

WCS-2, WCS-4, WCS-6, WCS-8: chicken sausage incorporated with 2% wheat bran and 2% dried carrot pomace, 2% wheat bran and 4% dried carrot pomace, 2% wheat bran and 6% dried carrot pomace, 2% wheat bran and 8% dried carrot pomace respectively.
RESULTS AND DISCUSSION
Sensory scores of chicken sausage incorporated with WB + DAP and WB + DCP are presented in Table 2. Colour scores increased with increase in DAP in WB + DAP treated sausages and significant increase in relation to control was observed in treatment WAP-4 containing 2% WB + 4% DAP. However, colour scores declined with increase in the level of DCP in WB+DCP treated sausages and significant decline in relation to control was noticed in treatment WCS-6 containing 2% WB + 6% DCP. Still, the colour scores for treatments WCS-6 and WCS-8 were about 7.0 indicating very good acceptability. Results indicate that increase in amount of DAP in chicken sausage resulted in desirable effect on colour scores whereas DCP addition contributed to slightly lower colour scores of the sausages. A desirable effect of DAP on colour might be due to the presence of apple peel in DAP which provided desirable red colour to sausages. DCP might contain carotenoids or more amount of yellow pigment contributing to slight dilution of red colour resulting in slightly less desirable colour to the sausages. Sensory scores of WAS-2 and WCS-2 containing 2% WB + 2% DAP and 2% WB + 2% DCP respectively for other sensory traits i.e. flavour, texture, juiciness, tenderness and overall acceptability were comparable with control. Scores for these sensory attributes declined significantly on further increase in fibre in both types of sausage. However, scores of treatments WAS-4 and WCS-4 containing 2% WB + 4% DAP and 2% WB + 4% DCP respectively were approximately 7.0 indicating very good acceptability. Treatments WAS-8 and WCS-8 containing 2% WB + 8% DAP and 2% WB + 8% DCP respectively were moderately acceptable in terms of sensory attributes. Results indicate that the degree of change in the organoleptic quality of meat products is influenced by the level of fibre used in the product. Masking of meaty flavour due to WB, DAP or DCP might have contributed to lower flavour of fibre incorporated sausages. Dietary fibres also affect different texture properties like springiness, cohesiveness, resilience of food matrix in which they are incorporated resulting in an effect on texture and tenderness. Fibre binds water which might be responsible for lesser juiciness scores of chicken sausages. Sensory acceptability of 3% DAP, 3% WB and 3% DCP incorporated chicken sausages was equivalent to control and a further addition of fibre contributed to a decrease in sensory acceptability (Yadav et al., 2016; 2018). Carrot dietary fibre added in a concentration above 3% in sobrassada, a dry fermented sausage resulted in inferior sensory scores in comparison to control (Eim et al., 2008). Yasarlar et al. (2007) observed that increase in bran level in meat balls resulted in masking of meaty flavour with diminished sensory quality.

Hardness scores of chicken sausage increased with increase in fibre level (Table 3). The significant difference in relation to control was observed in WAS-6 treatment in WB + DAP incorporated sausage. All WCS treatments were significantly harder than control. Except for WAS-2 treatment, springiness scores of both varieties of sausages were significantly lower in comparison to control. Cohesiveness values also declined significantly with increase in fibre in both types of sausages. Influence of fibre incorporation on texture attribute of sausages was also noticed by sensory panellists as discussed earlier. Garcia et al. (2007) observed a visible increase in hardness on the addition of wheat and oat fibre to dry fermented sausage due to their insoluble dietary fibre content. An increase in the percentage of carrot dietary fibre caused a significant increase in hardness of sobrassada (Eim et al., 2008). Fernandez-Gines et al. (2003) prepared bologna sausage

Table 2: Sensory scores of chicken sausage incorporated with combination of wheat bran with dried apple pomace or dried carrot pomace.

| Treatment | Colour and appearance | Flavour | Texture | Juiciness | Tenderness | OAA |
|-----------|------------------------|---------|---------|-----------|------------|-----|
| Control  | 7.33±0.48a             | 7.67±0.48a | 7.62±0.49a | 7.55±0.40a | 7.63±0.47a | 7.55±0.38a |
| WAS-2    | 7.45±0.46ab            | 7.58±0.40a | 7.40±0.44a | 7.42±0.32a | 7.57±0.34a | 7.42±0.30a |
| WAS-4    | 7.63±0.40a             | 6.92±0.49a | 7.00±0.47a | 6.92±0.56a | 7.00±0.49a | 7.08±0.47a |
| WAS-6    | 7.67±0.48a             | 6.37±0.54a | 6.45±0.50a | 6.33±0.51a | 6.42±0.56a | 6.42±0.53a |
| WAS-8    | 7.63±0.47a             | 5.95±0.33a | 6.18±0.38a | 5.95±0.42a | 6.13±0.35a | 6.00±0.44a |

Chicken sausages incorporated with wheat bran and dried carrot pomace

| Treatment | Colour and appearance | Flavour | Texture | Juiciness | Tenderness | OAA |
|-----------|------------------------|---------|---------|-----------|------------|-----|
| Control  | 7.53±0.49a             | 7.63±0.47a | 7.53±0.47a | 7.55±0.48a | 7.62±0.49a | 7.55±0.44a |
| WAS-2    | 7.45±0.48a             | 7.43±0.49a | 7.30±0.47a | 7.33±0.48a | 7.43±0.49a | 7.33±0.44a |
| WAS-4    | 7.33±0.48a             | 6.93±0.41a | 7.05±0.40a | 7.00±0.32a | 7.08±0.37a | 7.05±0.40a |
| WAS-6    | 7.00±0.49a             | 6.37±0.54a | 6.32±0.52a | 6.37±0.51a | 6.42±0.56a | 6.32±0.50a |
| WAS-8    | 6.92±0.49a             | 5.88±0.31a | 6.00±0.44a | 5.97±0.32a | 6.05±0.33a | 5.97±0.39a |

WAS-2, WAS-4, WAS-6, WAS-8= chicken sausage incorporated with 2% wheat bran and 2% dried apple pomace, 2% wheat bran and 4% dried apple pomace, 2% wheat bran and 6% dried apple pomace, 2% wheat bran and 8% dried apple pomace respectively.

WCS-2, WCS-4, WCS-6, WCS-8= chicken sausage incorporated with 2% wheat bran and 2% dried carrot pomace, 2% wheat bran and 4% dried carrot pomace, 2% wheat bran and 6% dried carrot pomace, 2% wheat bran and 8% dried carrot pomace respectively.

Means with different superscripts within a column for a particular parameter differ significantly (p<0.05).
by adding 0.5 to 2.0 % of dried citrus fibre and observed an increase in hardness and decrease in springiness and cohesiveness in relation to control sausage. The consistency of meat products is increased due to formation of an insoluble three-dimensional network by insoluble dietary fibre (Backers and Noll, 1997) which can effect the rheological quality of the emulsions. In the present study also, hardness increased in both types of treatments but it was more marked in WB + DCP treatments in comparison to WB + DAP treatments. Gumminess scores of WB + DAP incorporated sausages were statistically identical to control and a significant increase was noticed only in WAS-8 treatment. In WB + DCP treated sausage, gumminess scores of treatment WCS-2 were comparable with control and all other treatments had significantly higher gumminess scores. WAS-2 and WAS-4 treatments had significantly lower chewiness scores in relation to control. In WB + DCP treated sausage, chewiness scores of WCS-2 treatments were comparable with control and all other treatments had significantly higher chewiness scores. Gumminess and chewiness scores of a meat product depend on its hardness, cohesiveness and springiness scores. Shear press value of chicken sausages was comparable with control up to treatment WAS-4 in WB + DAP treated sausages and up to treatment WCS-2 in WB + DCP treated sausages. Further increase in fibre level in chicken sausages contributed to a significant rise in their shear press value.

Fibre addition to meat products influence their colour as discussed before. The results were also validated by instrumental colour evaluation. Lightness (L*) of WB + DAP

**Table 3:** Instrumental texture properties of chicken sausage incorporated with combination of wheat bran with dried apple pomace or dried carrot pomace. (n=6, mean ± SD)

| Treatment | Hardness | Springiness | Cohesiveness | Gumminess | Chewiness | Shear press value |
|-----------|----------|-------------|--------------|-----------|-----------|------------------|
| Control   | 26.85±2.05ab | 0.84±0.03ab | 0.54±0.05ab | 14.64±2.33bc | 12.30±1.82ab | 5.51±0.78ab      |
| WAS-2     | 27.48±2.94a  | 0.83±0.01ab | 0.46±0.03ab | 12.64±1.71bc | 10.43±1.43a  | 5.56±0.81ab      |
| WAS-4     | 30.14±2.67a  | 0.80±0.01ab | 0.44±0.02bc | 13.22±1.14bc | 10.51±0.94a  | 6.07±0.27ab      |
| WAS-6     | 36.47±3.07a  | 0.77±0.01cd | 0.41±0.02de | 15.02±1.51b  | 11.53±1.06ab | 7.23±0.54ab      |
| WAS-8     | 44.83±3.19a  | 0.73±0.02de | 0.39±0.02de | 17.33±1.48a  | 12.75±1.33ab | 8.53±0.48ab      |
| Control   | 24.36±1.02ab | 0.85±0.02ab | 0.55±0.05ab | 13.27±0.92bc | 11.30±0.65ab | 5.16±0.55ab      |
| WCS-2     | 28.14±1.09ab | 0.83±0.01ab | 0.49±0.03ab | 13.68±1.19ab | 11.33±0.98ab | 5.34±0.28ab      |
| WCS-4     | 40.34±1.62a  | 0.79±0.02ab | 0.48±0.04ab | 19.21±2.36ab | 15.11±1.77ab | 7.12±0.49ab      |
| WCS-6     | 44.53±1.45a  | 0.79±0.00ab | 0.41±0.02ab | 18.28±1.60bc | 14.44±1.25bc | 8.18±0.78ab      |
| WCS-8     | 53.16±1.18a  | 0.76±0.01ab | 0.42±0.02ab | 22.22±1.55bc | 16.96±0.99ab | 9.17±0.54ab      |

**Table 4:** Instrumental colour properties of chicken sausage incorporated with combination of wheat bran with dried apple pomace or dried carrot pomace. (n=6, mean ± SD)

| Treatment | Lightness (L*) | Redness (a*) | Yellowness (b*) |
|-----------|----------------|--------------|-----------------|
| Control   | 57.74±2.39a    | 6.61±0.56ab  | 17.90±0.87a     |
| WAS-2     | 57.25±2.45ab   | 6.46±0.87ab  | 17.95±0.76a     |
| WAS-4     | 54.71±3.12abc  | 6.88±0.48ab  | 18.49±0.53a     |
| WAS-6     | 53.90±3.05abc  | 7.37±0.64ab  | 18.40±0.71a     |
| WAS-8     | 52.02±2.34abc  | 7.44±0.75ab  | 18.43±0.94a     |
| Control   | 58.24±2.67a    | 6.81±0.56ab  | 17.40±0.87a     |
| WCS-2     | 59.60±1.50a    | 6.41±0.69ab  | 18.43±0.83a     |
| WCS-4     | 58.87±2.83a    | 6.48±0.37ab  | 19.17±0.72a     |
| WAS-6     | 59.51±2.43a    | 6.13±0.34ab  | 19.10±0.96a     |
| WCS-8     | 58.82±2.63a    | 6.09±0.51ab  | 19.44±0.45a     |

Means with different superscripts within a column for a particular parameter differ significantly (p<0.05).
treated sausage decreased and significant decline in relation to control was observed in treatments WAS-6 and WAS-8 (Table 4). Redness values of control and fibre incorporated sausages were found to be statistically similar. But significantly higher redness scores were observed in treatments WAS-6 and WAS-8 in comparison to treatment WAS-2. No significant variation was noticed in yellowness (b*) values between control and treated sausages. Results indicate that WB + DAP addition resulted in darker sausages and DAP also contributed towards redness of sausages. Anthocyanins responsible for the red colour in apple peel (Lancaster et al., 1994; Reay, 1999) might have contributed to redness in apple pomace resulting in desirable colour at a higher level of DAP incorporation in WB+DAP treated sausages. In WB+DCP treated sausage, no significant distinction was observed in lightness values. Redness values decreased progressively and significant decline in relation to control was found in treatments WCS-6 and WCS-8. Yellowness improved significantly in all WB+DCP incorporated sausages. Results indicate that increase in DCP level resulted in chicken sausages with lower redness and higher yellowness values. Increased yellowness of WB+DCP incorporated sausages might be due to the presence of phytochemicals. Sun et al. (2009) have reported the presence of carotenoids, flavonoids and anthocyanins which provide different colours in different varieties of carrot.

CONCLUSION
Wheat bran along with byproducts of apple processing (dried apple pomace) and carrot processing (dried carrot pomace) can be successfully incorporated as a dietary fibre source in chicken sausage. Dietary fibre incorporated chicken sausages with very good organoleptic acceptance can be prepared by adding wheat bran (2%) + dried apple pomace (4%) or wheat bran (2%) + dried carrot pomace (4%).

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