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# Quality of Low Fat Chicken Nuggets: Effect of Sodium Chloride Replacement and Added Chickpea (*Cicer arietinum* L.) Hull Flour

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**ABSTRACT :** While attempting to develop low salt, low fat and high fibre chicken nuggets, the effect of partial (40%) common salt substitution and incorporation of chickpea hull flour (CHF) at three different levels viz., 5, 7.5 and 10% (Treatments) in pre-standardized low fat chicken nuggets (Control) were observed. Common salt replacement with salt substitute blend led to a significant decrease in pH, emulsion stability, moisture, ash, hardness, cohesiveness, gumminess and chewiness values while incorporation of CHF in low salt, low fat products resulted in decreased emulsion stability, cooking yield, moisture, protein, ash, color values, however dietary fibre and textural properties were increased ($p<0.01$). Lipid profile revealed a decrease in total cholesterol and glycolipid contents with the incorporation of CHF ($p<0.01$). All the sensory attributes except appearance and flavor, remained unaffected with salt replacement, while addition of CHF resulted in lower sensory scores ($p<0.01$). Among low salt, low fat chicken nuggets with CHF, incorporation CHF at 5% level was found optimum having sensory ratings close to very good. Thus most acceptable low salt, low fat and high fibre chicken nuggets could be developed by a salt replacement blend and addition of 5% CHF. (**Key Words :** Chicken Nuggets, Physico-chemical Properties, Textural Properties, Chickpea Hull Flour)

## INTRODUCTION

There has been a dramatic shift in consumer eating habits in recent years. As consumers have become increasingly more health conscious, the trend is toward foods including meat products with decreased levels of fat, salt, cholesterol and caloric content as well as enriched with dietary fibre (Yang et al., 2007). Additionally, owing to concerns about obesity and diseases related to high-fat diets, many consumers now desire no fat or low-fat versions of their traditional foods. Health organizations all over the world have proposed limits to total fat intake to less than 30% of total calories (Koutsopoulos et al., 2008). It has also been advised to lower the intake of saturated fatty acids and cholesterol, as a means of preventing cardiovascular heart disease (AHA, 1986).

Current dietary sodium intake is clearly too high as compared to potassium, calcium and magnesium (Karpppanen and Mervaala, 2001), and excess sodium is associated with the development of hypertension. This resulted in recommendation of reduced dietary sodium intake by public health and regulatory authorities (Tuomilehto et al., 2001). Meat has a relatively low concentration of sodium, containing only 50 to 90 mg of sodium per 100 g (Romans et al., 1994), but processed meat products may contribute a significant amount (20-30%) of salt in the diet (Wirth, 1991). Thus, the pressure is mounting over meat industry to reduce the sodium content in processed meat products.

Dietary fibres are the key ingredient lacking in the meat and meat products and regular consumption of latter is being associated with various health disorders such as colon cancer, obesity and cardiovascular diseases (Tarrant, 1998; Larsson and Wolk, 2006). Dietary fibres are the remnants of the edible part of plants and analogous carbohydrates that are resistant to digestion and absorption in the human small intestine (Prosky, 1999). Various reports have revealed that intake of fibre reduces the risk of such diseases (Johnson and Southgate, 1994). Hence, enrichment of meat products with dietary fibres from various sources would help to enhance their nutritional composition and desirability as well.

The reduction/replacement of sodium from and addition of dietary fibre in meat products could be an avenue to meet

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the consumer's expectations. An attempt to reduce the common salt or sodium content in meat products have been made by various workers in different meat products (Ruusunen et al., 1999; Gelabert et al., 2003; Jiménez-Colmenero et al., 2005; Ruusunen et al., 2005; Guàrdia et al., 2008; López-López et al., 2009). As far as meat with dietary fibre is concerned various ingredients such as oat fibre (Claus and Hunt, 1991), peach fibre (Griguelmo-Miguel et al., 1999), apple pulp (Verma et al., 2010), oat bran (Yılmaz and Dağlıoğlu, 2003) and rice bran as well as different fibres (Huang et al., 2005; 2011) have been used in meat products.

Of late, various researches have been directed towards potential use of legumes in development of functional foods. Pulses are a rich food source of dietary fibres that promote various beneficial physiological effects for human health (Tosh and Yada, 2010) and contribute energy, proteins, vitamins and minerals (Serdaroğlu et al., 2005). The use of chickpea flour for the preparation of low-fat pork bologna has been reported (Sanjeewa et al., 2010). However in our best of knowledge there is no report in the literature on utilization of chickpea seed coat (hulls) in the meat products. Crude fibre in chickpeas ranges between 7.1 and 13.5% and contains cellulose and hemicellulose, which is mainly concentrated in the seed coat (Chavan et al., 1986). Therefore, the present study was undertaken to partially replace common salt from and incorporate chickpea (*Cicer arietinum* L.) hull flour (CHF) in pre-standardized low fat chicken nuggets (2% NaCl) and observe their effects on various quality characteristics of the products.

## MATERIALS AND METHODS

### Raw materials

Freshly slaughtered and dressed chickens (spent hen of 71-72 wk age), procured from Central Avian Research Institute, Izatnagar, were quickly brought to the laboratory of Livestock Products Technology Division. After deboning, all meat without skin was packaged in polyethylene bags and stored overnight at 4±1°C in a refrigerator and then stored frozen at -18°C till further use. Other additives used were sodium chloride (Tata Chemicals Ltd., Mumbai), salt substitute blend composed of potassium chloride (0.2%), citric acid (0.03%), tartaric acid (0.03%) and sucrose (1%) (Qualigens Fine Chemicals, Mumbai), sodium hexametaphosphate (Shital Enterprise, Ahmedabad), sodium nitrite (Merck Specialities Private Ltd., Mumbai, India), refined sunflower oil (Agro Tech Foods Ltd., New Delhi, India), carrageenan, sodium alginate (CDH Private Ltd., New Delhi, India), liquid egg white, chickpea hull flour (CHF), condiments (onion and garlic paste), refined wheat flour and spice mix. CHF was prepared by grinding of dried chickpea hulls to the consistency of flour followed by sieving.

### Detailed study

In the study 40 percent of common salt of pre-standardized low fat chicken nuggets (LF) was substituted by the salt replacement blend to get low salt, low fat chicken nugget (LS/LF). In the resultant product, CHF was incorporated as a source of dietary fibre at three different levels i.e. 5, 7.5 and 10%. These low salt, low fat (LS/LF) and low salt, low fat and high fibre chicken nuggets (LS/LF/CHF) were compared for various physico-chemical, color, textural, lipid profile and sensory properties against control (LF) which is a pre-standardized low fat chicken nuggets with 2% common salt.

### Chicken nuggets manufacture

The formulation of control and treated nuggets, having partially replaced common salt and different levels of CHF is given in Table 1. All the ingredients and minced-chicken meat constituents were thoroughly mixed and chopped in a bowl chopper (Seydelmann K20, Ras, Germany) to prepare the emulsion. About 360 g of emulsion was taken and filled in stainless steel mould. Mould was covered with lid and tied with thread and steam cooked for pre-standardized 35 min to achieve an internal temperature of about 85°C.

**Table 1.** Product formulation for the different chicken nuggets

| Ingredients | LF (Control) | LS/LF | LS/LF/CHF | | |
|---|---|---|---|---|---|
| | | | 5% | 7.5% | 10% |
| Lean meat (%) | 74.65 | 74.19 | 69.19 | 66.69 | 64.19 |
| Sodium chloride (%) | 2.0 | 1.2 | 1.2 | 1.2 | 1.2 |
| Potassium chloride (%) | - | 0.2 | 0.2 | 0.2 | 0.2 |
| Citric acid (%) | - | 0.03 | 0.03 | 0.03 | 0.03 |
| Tartaric acid (%) | - | 0.03 | 0.03 | 0.03 | 0.03 |
| Sucrose (%) | - | 1 | 1 | 1 | 1 |
| Chickpea hull flour (%) | - | - | 5 | 7.5 | 10 |

LF = Low fat chicken nuggets; LS/LF = Low salt, low fat chicken nuggets; LS/LF/CHF = Low salt, low fat chicken nuggets with chickpea hull flour.
The following were also added to all samples: 0.5% sodium hexametaphosphate, 150 ppm sodium nitrite, 6.5% ice flakes, 1.5% liquid egg white, 7% refine sunflower oil, 3% condiment mix, 0.75% carrageenan, 0.1% sodium alginate, 2% spice mix and 2% refined wheat flour.

Chicken meat blocks so obtained were sliced and cut into pieces to get nuggets (~15 $mm^3$).

**Product analysis**

*Preparation of samples* : Six samples (duplicate in three batches) for all five products (control and four treatments) were evaluated for various parameters such as pH, cooking yield, proximate composition, dietary fibre, and color, texture profile analysis as well as lipid profile. In case of sensory analysis 30 samples were analysed (ten samples in three batches) and for emulsion stability analysis of 9 samples (triplicate in three batches) was conducted.

*pH determination* : The pH of emulsion and cooked products was determined by blending 10 g of sample with 50 ml of distilled water using an Ultra Turrax T25 tissue homogenizer (Janke and Kunkel, IKA Labortechnik, Staufen, Germany) at 8,000 rpm for 1 min. The pH of the suspension was recorded by dipping combined glass electrode of Elico digital pH meter, Model LI 127 (Elico Limited, Hyderabad, India).

*Emulsion stability and cooking yield*: Emulsion stability (ES) was determined using the method described by Townsend et al. (1968) with some modifications. About 25 g emulsion samples were placed in polyethylene bags and heated at 80°C in a thermostatically controlled water bath for 20 min. After draining out the exudate, the cooked mass was cooled, weighed and the yield was expressed as percent emulsion stability. Cooking yield was determined by measuring weight of meat blocks for each treatment and calculating the ratio of cooked weight to raw weight and expressed as a percentage.

*Proximate analysis and dietary fibre*: Moisture, protein, fat, ash and dietary fibre contents of the product were determined as per the standard procedures of Association of Official Analytical Chemists (AOAC, 1995).

*Instrumental color*: The color of cooked chicken nuggets was compared using a Lovibond Tintometer (Model F; UK). Samples from two different nuggets were taken in the sample holder and secured against the viewing aperture. The sample color was matched by adjusting red (a) and yellow (b) units, while keeping the blue units fixed at 2. The corresponding color units were recorded. The hue and chroma (saturation) values were determined using the formula, ($\tan^{-1}$ b/a) (Little, 1975) and $(a^2+b^2)^{1/2}$ (Froehlich et al., 1983), respectively, where, a, is the red unit, b the yellow unit.

*Texture profile analysis*: The textural properties of nuggets were evaluated using the texturometer (Stable Micro System Model TA.XT 2i/25, UK) at Post Harvest Technology, Central Avian Research Institute, Izatnagar. Texture profile analysis (Bourne, 1978) was performed using central cores of two pieces of each sample (1.5×1.5×1.5 cm) which were compressed twice to 60% of the original height. A crosshead speed of 3 mm/s was used applying 0.15 N load cell and 75 mm compression platen probe (P75).

*Lipid profile*: The fat content of the samples were extracted according to Folch et al. (1957) and total lipids were determined gravimetrically. The different components of lipids, including total phospholipids, glycolipids and free fatty acids (FFA) were measured by standard procedures as described by Marinetti (1962), Raughan and Batt (1968) and Koniecko (1979), respectively, whereas total glycerides were indirectly calculated by subtracting all these from total lipid values. Total cholesterol content in the lipid extracts was determined according to procedure described by Sabir et al. (2003) using Liberman-Burchard reagent. The developed color complex was measured by reading the optical density at 640 nm in a spectrophotometer (Elico, Scanning minispec SL 117) and expressed as mg per g of product.

*Organoleptic evaluation*: Sensory evaluation method using an 8 point descriptive scale (Keeton, 1983) was followed, where 8 = excellent; 1 = extremely poor. The sensory panel consisted of ten trained scientists and post graduate students of the division. Three digit coded samples were served to the panelists in random order. The nature of experiments was explained to the panelists without disclosing the identity of samples. The sensory panelists were asked to rate their preference on 8 point descriptive scale on the sensory evaluation proforma for different traits. Samples were warmed using microwave oven for 1 min. Water was provided to rinse mouth between the samples. The panelists judged the samples for general appearance, flavor, texture, saltiness, juiciness and overall acceptability.

**Statistical analysis**

The statistical design of the study was 5 (treatment)× 3 (replication) randomized block design. All chemical and physical determinations were in triplicate. There were ten sensory determinations for each treatment-replication combination. Data were subjected to one way analysis of variance. Duncan's multiple range tests and critical difference were determined at the 5% significance level (Snedecor and Cochran, 1995).

## RESULTS AND DISCUSSION

**Emulsion and product pH**

The emulsion and product pH values of LS/LF and LS/LF/CHF were significantly lower ($p<0.01$) than LF (Table 2). There was non-significant increase ($p>0.05$) in these values as the levels of CHF increased. The treatment formulations contained food grade acids which could be the reason for lower pH values. Incorporation of CHF in low salt, low fat chicken nuggets might have diluted the acidity

**Table 2.** Effect of common salt replacement and added chickpea hull flour on the physico-chemical properties of low fat chicken nuggets

| Parameters | LF (Control) | LS/LF | LS/LF/CHF | | |
|---|---|---|---|---|---|
| | | | 5% | 7.5% | 10% |
| Emulsion pH | 5.88±0.01[a] | 5.66±0.02[c] | 5.72±0.004[b] | 5.74±0.01[b] | 5.75±0.01[b] |
| Product pH | 6.01±0.01[a] | 5.78±0.04[b] | 5.82±0.02[b] | 5.84±0.01[b] | 5.85±0.01[b] |
| Emulsion stability* (%) | 93.42±0.52[a] | 93.30±0.20[a] | 91.51±0.39[b] | 90.97±0.55[bc] | 90.24±0.28[c] |
| Cooking yield (%) | 95.88±0.13[a] | 95.07±0.18[b] | 94.44±0.43[bc] | 94.17±0.16[c] | 94.07±0.31[c] |
| Moisture (%) | 66.15±0.05 [a] | 63.99±0.20[b] | 64.07±0.37 [b] | 63.22±0.65[bc] | 62.43±0.32[c] |
| Protein (%) | 17.21±0.28[a] | 16.91±0.60[a] | 14.88±0.59[b] | 14.21±0.37[b] | 13.93±0.73[b] |
| Moisture protein ratio | 3.99±0.11a[b] | 3.81±0.13[b] | 4.34±0.16[ab] | 4.49±0.20[a] | 4.55±0.27[a] |
| Fat (%) | 8.83±0.16 | 9.16±0.07 | 9.17±0.16 | 9.15±0.14 | 9.07±0.12 |
| Ash (%) | 3.14±0.04[a] | 2.77±0.07[b] | 2.68±0.02[b] | 2.66±0.11[b] | 2.65±0.07[b] |
| Dietary fibre (%) | 0.87±0.04[d] | 0.87±0.03[d] | 3.39±0.06[c] | 5.05±0.06[b] | 6.53±0.10[a] |

LF = Low fat chicken nuggets; LS/LF = Low salt, low fat chicken nuggets; LS/LF/CHF = Low salt, low fat chicken nuggets with chickpea hull flour.
Mean with the different superscripts row-wise differ significantly ($p<0.05$). Values are the means±SE. n = 6; * n = 9.

of meat batter as pH of CHF is almost neutral (6.93). Increase in the pH values with the addition of CHF was also in accordance with the findings of Yilmaz (2004), who reported increase in the pH value with the increasing levels of rye bran in low fat meatballs.

**Emulsion stability and cooking yield**

There was non-significant decrease in the emulsion stability of LS/LF, however LS/LF/CHF products had significantly lower ($p<0.01$) value than control and LS/LF and stability was further decreased with higher levels of CHF with significant effect at 10% level of CHF (Table 2). Common salt plays significant role in meat proteins extraction that is responsible for water and fat binding and ultimately stabilizing the meat batter. As treatment products contained lower amount of sodium chloride which might have decreased the concentration of extracted protein involved in formation of the gel/emulsion matrix and the replacement of lean meat by CHF. According to Sofos (1986) one of the functions of NaCl in meat products is to extract myofibrillar proteins, which contribute to meat particle binding, fat emulsification, water holding capacity and thus reduce cook losses and improve quality and texture. Sodium chloride solubilises meat proteins, and this increases the number of locations in the polypeptide chains capable of interacting during heating. As a result there is a formation of stable, elastic and rigid protein gel matrix with good water and fat binding properties (Carballo et al., 1995). Reduction in gel strength of frankfurter batters with the decreasing salt content was also reported by Whiting (1984). Both salt replacement and CHF addition resulted in significant decrease ($p<0.01$) in the cooking yield of treatment products. Cooking yield was further decreased with inclusion levels of CHF and significant effect at higher than 7.5% level was observed. Yield of the meat products mainly depends upon batter stability, which is determined by the concentration of extracted proteins. Since treated products had comparatively lesser emulsion stability they lost more water while cooking and received low product yield. The present result was in accordance with the findings of Ruusunen et al. (2005) who reported a marked increase in cooking loss of ground meat patties as sodium chloride level was reduced. The cooking loss and total fluid release was significantly higher in low sodium frankfurter containing transglutaminase, KCl, sodium caseinate and dietary fibre as salt replacers (Jiménez-Colmenero et al., 2005). Hsu and Sun (2006) reported significant increase in cooking yield of *Kung-wans* at higher salt levels.

**Proximate analysis and dietary fibre**

Salt replacement significantly decreased ($p<0.01$) the moisture percent and later was further reduced with addition of CHF with significant effect at 10% level (Table 2). Higher moisture percent in control product could be due to higher common salt content, which allowed more meat protein extraction and thus more moisture binding (Somboonpanyakul et al., 2007) in comparison to poor water binding by CHF. According to Gordon and Barbut (1992), increasing NaCl from 1.5 to 2.5% resulted in a more protein extraction in chicken meat batter. A decrease in moisture percent of low fat ground beef patties (Troutt et al., 1992) and low fat dry fermented sausages (Mendoza et al., 2001) containing texture modifying ingredients and inulin, respectively have been observed. Yılmaz (2004) reported decrease in moisture content in low fat meatballs added with different levels of rye bran. Similar finding was also reported by Yılmaz and Dağlıoğlu (2003) in meatballs with oat brans.

The protein percent in LS/LF nuggets was almost similar to control. However, LS/LF/CHF products had significantly lower ($p<0.01$) protein percent with gradual decrease in the value as the level of CHF increased. This

**Table 3.** Effect of common salt replacement and added chickpea hull flour on the colour properties of low fat chicken nuggets

| Parameters | LF (Control) | LS/LF | LS/LF/CHF | | |
|---|---|---|---|---|---|
| | | | 5% | 7.5% | 10% |
| Redness | 2.83±0.05[a] | 2.68±0.09[ab] | 2.63±0.04[b] | 2.42±0.07[c] | 2.28±0.05[c] |
| Yellowness | 3.20±0.06[ab] | 3.35±0.04[a] | 2.97±0.18[b] | 2.65±0.12[c] | 2.43±0.07[c] |
| Hue | 50.76±1.61[ab] | 45.64±1.41[b] | 51.33±2.12[ab] | 52.72±2.73[a] | 53.99±2.39[a] |
| Chroma | 4.28±0.04[a] | 4.30±0.07[a] | 3.97±0.16[b] | 3.60±0.09[c] | 3.34±0.04[c] |

LF = Low fat chicken nuggets; LS/LF = Low salt, low fat chicken nuggets; LS/LF/CHF = Low salt, low fat chicken nuggets with chickpea hull flour. Mean with the different superscripts row-wise differ significantly ($p<0.05$). Values are the means±SE. n = 6.

might be due to replacement of lean by CHF in the LS/LF/CHF formulations. Lin and Lin (2004) reported decrease in protein percent with increasing levels of bacterial cellulose (*Nata*) in Chinese style meatballs. The protein percent of low fat beef patties containing polydextrose and oat flour as texture modifying ingredients was significantly decreased (Troutt et al., 1992). Similar result was also observed by Huang et al. (2005) in emulsified pork meatballs incorporated with rice bran at the level of 5% and above. Moisture protein ratio in LS/LF product was significantly lower ($p<0.05$) than control and low fat, low salt products with 7.5 and 10% CHF. As expected the fat content remained almost similar ($p>0.05$) for control as well as treatment due same level of added vegetable oil in control and treatment. Ash content in the control nuggets was significantly higher ($p<0.01$) than treatments. Mendoza et al. (2001) obtained similar result in low fat dry fermented sausages incorporated with inulin as a fat substitute. There was significant decrease in ash content in low sodium frankfurter with transglutaminase, potassium chloride, sodium caseinate and dietary fibre as salt replacers (Jiménez-Colmenero et al., 2005). However, the differences in the ash content among treatments were non-significant. The dietary fibre contents in LS/LF/CHF products were significantly higher ($p<0.01$) than control and LS/LF. Fibre content was further increased ($p<0.01$) with the increasing levels of CHF. The present finding becomes noteworthy particularly when diet and wellbeing are being correlated in recent years, which was solely attributed to added chickpea hull flour.

**Instrumental color**

Replacement of common salt did not affect color parameters except hue value (Table 3). However, incorporation of CHF in low salt, low fat nuggets (LS/LF/CHF) significantly decreased ($p<0.01$) the redness, yellowness and chroma values. These values were further affected ($p<0.01$) beyond 5% level of chickpea hull flour. Slightly greyish color of CHF could be the reason for decrease in color values of products at higher levels. Fernández-Ginés et al. (2004) reported decrease in the redness of bologna sausages incorporated with raw and cooked lemon albedo as a source of dietary fibre. Incorporation of wheat bran and oat bran significantly decreased the redness of low fat meat balls (Yılmaz and Dağlıoğlu, 2003; Yılmaz, 2005).

**Textural characteristics**

Texture profile analysis revealed significant decrease ($p<0.01$) in hardness, cohesiveness, gumminess and chewiness with replacement of common salt (Table 4). The higher amount of common salt in control formulation could have resulted more extraction of salt soluble proteins (Hsu and Sun, 2006) that play a major role in the formation of firm three dimensional gel matrix and textural properties of meat products. Matulis et al. (1995) reported an increase in product hardness with increase in salt and fat content. However incorporation of CHF in low salt, low fat products increased these values and product with 10% CHF had almost similar hardness, cohesiveness, gumminess and chewiness to control. Huang et al. (2005) reported increase in hardness value with the increasing levels of rice bran in

**Table 4.** Effect of common salt replacement and added chickpea hull flour on the textural properties of low fat chicken nuggets

| Parameters | LF (Control) | LF/LS | LF/LS/CHF | | |
|---|---|---|---|---|---|
| | | | 5% | 7.5% | 10% |
| Hardness ($N/cm^2$) | 57.88±3.98[a] | 42.23±1.39[b] | 44.46±0.97[b] | 47.90±2.14[b] | 61.14±3.19[a] |
| Adhesiveness (Ns) | 0.02±0.01 | 0.02±0.02 | 0.02±0.01 | 0.02±0.01 | 0.02±0.01 |
| Springiness (cm) | 0.82±0.02 | 0.82±0.01 | 0.80±0.01 | 0.80±0.01 | 0.82±0.01 |
| Cohesiveness (ratio) | 0.43±0.01[ab] | 0.36±0.01[c] | 0.40±0.01[b] | 0.43±0.01[ab] | 0.44±0.01[a] |
| Gumminess ($N/cm^2$) | 24.82±1.27[a] | 15.26±0.52[c] | 17.96±0.64[bc] | 20.55±1.15[b] | 24.47±1.32[a] |
| Chewiness (N/cm) | 20.16±0.65[a] | 12.49±0.46[c] | 14.38±0.49[bc] | 16.41±0.82[b] | 20.01±1.00[a] |

LF = Low fat chicken nuggets; LS/LF = Low salt, low fat chicken nuggets; LS/LF/CHF = Low salt, low fat chicken nuggets with chickpea hull flour. Mean with the different superscripts row-wise differ significantly ($p<0.05$). Values are the means±SE. n = 6.

**Table 5.** Effect of common salt replacement and added chickpea hull flour on the lipid profile of low fat chicken nuggets

| Parameters | LF (Control) | LF/LS | LF/LS/CHF | | |
|---|---|---|---|---|---|
| | | | 5% | 7.5% | 10% |
| Total lipid (mg/g) | 70.17±2.18 | 69.83±2.17 | 69.16±0.91 | 68.33±1.12 | 66.83±1.83 |
| Total phospholipids (mg/g) | 6.81±0.24 | 6.80±0.25 | 6.72±0.27 | 6.57±0.20 | 6.48±0.18 |
| Total cholesterol (mg/g) | 1.05±0.01$^{a}$ | 1.04±0.01$^{a}$ | 0.88±0.02$^{b}$ | 0.83±0.01$^{c}$ | 0.76±0.01$^{d}$ |
| Total glycolipid (mg/g) | 0.09±0.01$^{a}$ | 0.09±0.01$^{a}$ | 0.09±0.01$^{a}$ | 0.08±0.01$^{a}$ | 0.07±0.01$^{b}$ |
| Free fatty acid (mg/g) | 0.99±0.04 | 0.98±0.04 | 0.96±0.02 | 0.95±0.02 | 0.94±0.02 |
| Total glyceride (mg/g) | 61.23±2.17 | 60.90±2.02 | 59.51±1.45 | 58.50±0.92 | 58.34±1.98 |

LF = Low fat chicken nuggets; LS/LF = Low salt, low fat chicken nuggets; LS/LF/CHF = Low salt, low fat chicken nuggets with chickpea hull flour.
Mean with the different superscripts row-wise differ significantly (p<0.05). Values are the means±SE. n = 6.

the emulsified pork meatballs. Similar result was also reported by García et al. (2002) in low fat dry fermented sausages added with 3% wheat and oat. However, decrease in hardness value of low fat, high dietary fibre frankfurters incorporated with peach dietary fibre was reported by Grigelmo-Miguel et al. (1999). Lin and Lin (2004) reported a decrease in cohesiveness value with the increasing levels of bacterial cellulose (*Nata*) in Chinese style meatballs. Grigelmo-Miguel et al. (1999) reported an increase in gumminess value of low fat, high dietary fibre frankfurters as the concentrations of peach fibre increased. The chewiness value of frankfurter was significantly decreased by replacement of sodium chloride with transglutaminase, potassium chloride, sodium caseinate and dietary fibre (Jiménez-Colmenero et al., 2005). Increase in the chewiness value of emulsified pork meatballs with respect to higher levels of rice bran was also reported (Huang et al., 2005).

**Lipid profile**

The lipid profile of control and LS/LF products was almost similar, but low salt, low fat products with CHF had lower values than control and LS/LF nuggets (Table 5). All the parameters were gradually decreased with higher levels of chickpea hull flour. Total cholesterol content was significantly decreased ($p<0.01$) at each level of CHF but total glycolipid was only affected at ($p<0.01$) 10% level. A decrease in lipid parameters of LS/LF/CHF observed in present study might be due to replacement of lean meat and ultimately meat fat by chickpea hull flour. The reduction of total cholesterol in the LS/LF/CHF products has a great importance from the consumer's health point of view as it is one of the main determinants for the chronic heart diseases. Cengiz and Gokoglu (2005) reported decrease in the cholesterol content of frankfurter-type sausages incorporated with citrus fibre and soy protein concentrate as fat replacer. Reducing the percentage of fat in the product was not a viable method for lowering cholesterol in meat derivatives and less cholesterol could be obtained by replacing fat and lean meat raw materials (since dietary cholesterol is strictly linked to animal cells) with other vegetable materials containing no cholesterol (Jimenez-Colmenero et al., 2001). The cholesterol content of uncooked and cooked beef burgers decreased with addition of wheat fibres (Mansour and Khalil, 1997).

**Organoleptic evaluation**

Sensory evaluation of products revealed that replacement of common salt affected ($p<0.05$) appearance and flavor. However, texture, saltiness, juiciness and overall acceptability scores were comparable to control (Table 6). Incorporation of chickpea hull flour resulted in significant decrease in the all sensory scores. Among LS/LF/CHF, the product with 5% chickpea hull flour had highest sensory ratings, where all the scores were close to very good (6.85 to 7.17). A slight grey color of CHF could be a contributing factor for lower general appearance score. Reduction in the

**Table 6.** Effect of common salt replacement and added chickpea hull flour on the organoleptic properties of low fat chicken nuggets

| Parameters | LF (Control) | LF/LS | LF/LS/CHF | | |
|---|---|---|---|---|---|
| | | | 5% | 7.5% | 10% |
| General appearance | 7.50±0.08$^{a}$ | 7.27±0.05$^{b}$ | 6.90±0.08$^{c}$ | 6.67±0.07$^{d}$ | 6.40±0.07$^{e}$ |
| Flavour | 7.38±0.06$^{a}$ | 7.12±0.05$^{b}$ | 6.90±0.09$^{b}$ | 6.52±0.10$^{c}$ | 6.31±0.11$^{c}$ |
| Texture | 7.33±0.06$^{a}$ | 7.22±0.04$^{a}$ | 6.85±0.06$^{b}$ | 6.63±0.07$^{c}$ | 6.40±0.08$^{d}$ |
| Saltiness | 6.98±0.09$^{ab}$ | 7.03±0.02$^{ab}$ | 7.17±0.08$^{a}$ | 7.05±0.08$^{ab}$ | 6.92±0.09$^{b}$ |
| Juiciness | 7.26±0.06$^{a}$ | 7.18±0.04$^{a}$ | 6.90±0.10$^{b}$ | 6.67±0.08$^{c}$ | 6.52±0.08$^{c}$ |
| Overall acceptability | 7.28±0.06$^{a}$ | 7.18±0.04$^{a}$ | 6.88±0.06$^{b}$ | 6.61±0.08$^{c}$ | 6.27±0.08$^{d}$ |

LF = Low fat chicken nuggets; LS/LF = Low salt, low fat chicken nuggets; LS/LF/CHF = Low salt, low fat chicken nuggets with chickpea hull flour.
Mean with the different superscripts row-wise differ significantly (p<0.05). Values are the means±SE. n = 30.

flavor score with the increasing levels of CHF might be due to dilution of meaty flavor. A significantly lower texture score of LS/LF/CHF products could be due to disruption of batter matrix by the addition of chickpea hull flour. Lower juiciness scores of LS/LF/CHF products with the increased levels of flour might be due to graininess perceived by sensory panelists (Claus and Hunt, 1991) and lower moisture percent in the product. Yılmaz and Dağlıoğlu (2003) reported decrease in juiciness score with increased levels of oat bran in meatballs. The lower general appearance, flavor, texture and juiciness might have contributed to the significantly lower overall acceptability score for low salt, low fat products with CHF. A decrease in overall acceptability score of emulsified pork meatballs with increasing levels of rice bran was observed by Huang et al. (2005). Similar result was also found by Yılmaz (2004) in low fat meatballs incorporated with rye bran.

## CONCLUSIONS

The present study indicated that common salt replacement and addition of chickpea hull flour significantly affected various quality characteristics of low fat chicken nuggets. The replacement of 40% common salt by blend did not affect organoleptic qualities except appearance and flavor. Addition of chickpea hull flour resulted significant increase in dietary fibre while decreased total cholesterol content. Incorporation of CHF significantly affected sensory attributes; however product with 5% chickpea hull flour was rated close to very good. A slight greyish color of chickpea hull flour was supposed to be the major reason for lower acceptability of such products. Thus low salt, low fat meat products could be developed without affecting acceptability of the products. Incorporation of 5% CHF in LS/LF products was found optimum with least effect on sensory ratings.

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