J Food Sci Technol (January–February 2013) 50(1):191–196
DOI 10.1007/s13197-012-0617-z

SHORT COMMUNICATION

Characteristics of chicken nuggets as affected by added fat and variable salt contents

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Revised: 28 August 2011 / Accepted: 13 January 2012 / Published online: 26 January 2012

Abstract Several studies have been conducted in many countries on how to increase the per capita consumption of poultry meat. With the growing demand for poultry meat, the development of value added product, such as chicken nuggets has been identified as the best way to increase poultry meat consumption. Apart from this allowing for the flourishing growth of fast food industries; chicken nuggets needs to be produced in higher quantity and to reduce cost, there is increasing interest in using of various meat additives. Though, chicken fat are edible, it is important to evolve production processes for gainful utilization of this part. So the main objective of this work was to study the effect of the addition of chicken fat and various salt contents on the physicochemical, proximate composition and sensory characteristics of chicken nuggets. Based on the results it is concluded that, even up to 5% level of chicken fat with 1.5–2% added salt there is no adverse effect in terms of physicochemical, proximate composition and sensory qualities of cooked chicken nuggets. Even, at this fat and salt level product was more preferred by panellist than no fat-no salt chicken nuggets.

Keywords Chicken nuggets · Fat and salt content · Product quality

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Introduction

Several studies have been conducted in many countries in the world on how to increase the per capita consumption of poultry meat. The development of value added product, such as chicken nuggets has been identified as the best way to increase poultry meat consumption. These pre-processed products are ready-to-fry and serve, and are gaining importance in the consumer market. Improvement of such product quality widens the marketability of chicken products.

The quality of nugget significantly affected by processing, raw material and ingredient factors either from nutritional value or overall acceptability by consumers. Only those nuggets with high nutritional value, low cholesterol, good textural properties, nice flavor and taste profile will become the favourite choice of consumers as flavour and texture, particularly juiciness and tenderness, have a clear relationship to meat palatability (Behrends et al. 2005; Calkins and Hodgen 2007).

Comminuted meat products are widely consumed, but unfortunately their cost, especially for the developing countries is high. To reduce cost, there is increasing interest in using of various meat additives. Though, chicken fat are edible, this do not have much consumer appeal in India (Biswas et al. 2007). Consequently, about 10.2 to 13% of the live weight is wasted in case of adult poultry (Sharma 1999). It is therefore important to evolve production processes for gainful utilization of this part.

Traditionally, processed meat products have high fat content, up to 30%, as fat provides sensory characteristics such as flavour, juiciness and mouth feel to the products and contributes to the texture of products. By lowering the fat content, the effect of some of these characteristics will be reduced and the products may become unacceptable. Studies on restructured chicken steak have shown that the product made with higher fat content was more preferred (Chuah 1994). According to Claus et al. (1989, 1990), reduced fat products can be produced by using leaner meats, adding water or other non-meat

ingredients. However, by increasing the lean meat content through reducing fat will result in a finer, more rubbery and less juicy product besides increasing the cost of production (Hand et al. 1987). Fat acts as a carrier and reservoir of aroma compounds, stimulates the senses during eating and acts as a precursor for certain flavours (Ventanas et al. 2010) Moreover, the amount and composition of fat and its physical state influence the dynamic release of flavour compounds during consumption (Hort and Cook 2007; Lucca and Tepper 1994; Akoh 1998). Overall, increasing the fat content involves a decrease in aroma release and in flavour intensity (De Roos 1997). Simple reduction in the fat content of processed meat products substantially reduces juiciness and tenderness (Brewer et al. 1992), cooking yield (Barbut and Mittal 1992) and product palatability. Alternatively, chicken fat disperses well in meat emulsion because of its high unsaturation and enhances the flavor of the products.

Salt content of a meat product is not a regulated ingredient but is self-limiting, because high concentrations will negatively affect the palatability of the product. Depending on the products, salt levels can range from 1.5 up to 3%. Salt (NaCl) is one of the oldest and most effective food preservatives used. Salt is included in poultry meat formulations to enhance product flavor (Rabe et al. 2003), textural properties of foods (Desmond 2006; Saint-Eve et al. 2009), increase moisture retention, act as a synergist with STP to extract salt-soluble proteins.

Fat and salt are some of the most interesting additives since their presence in meat products are in continuously discussion due to health considerations (Jiménez Colmenero 1996; Desmond 2006). In view of all aforesaid factors objective of this work was to study the effect of the addition of chicken fat and various salt contents on the physicochemical, proximate composition and sensory characteristics of chicken nuggets.

Materials and methods

Sample preparation (raw & cooked nuggets)

Boneless chicken from broiler of 6 week age was obtained from commercial shops in Ludhiana, Punjab. All subcutaneous and intramuscular fat were manually trimmed off. The chicken meat was minced using a commercial meat mincer (8 mm plate) and used in the formulation of nuggets. Four blends were formulated; each formulation contained 210 mg sodium nitrite, 6 g sugar, 6 g STPP, 30 g spice/meat masala, 37.2 g garlic paste, 37.2 g onion powder, 75 g eggs, 75 g soya, 75 g maida, 150 ml veg. oil, 150 ml water and 1,500 g minced chicken meat. To this mix was added 5% chicken fat and 1.5% salt (T1), 5% chicken fat and 2% salt (T2), 5% chicken fat and 2.5% salt (T3) while formulation T4 was control without chicken fat and salt. Each portion was mixed by gently blending in a bowl chopper for about 5 min to obtain a homogenous mix. The mixtures were filled into boxes (20×10 cm) (raw nuggets) and were cooked for 20 min to an inner temperature of 75 °C measured at the geometric centre at 180±1 °C. The boxes were turned over at 10 min intervals to ensure uniform cooking. After cooking the cooked material were cut into pieces to obtain chicken nuggets.

Determination of proximate composition

Moisture, protein, ash and fat content were determined according to the procedure outlined in [methods 950.46, 928.08, 920.153, 960.39 respectively; AOAC (2000)]. The carbohydrate content was obtained by subtracting the percent total of the moisture, fat, protein and ash contents from 100%.

pH

The pH was determined by blending 5 g sample in 50 ml of deionised distilled water. The mixture was filtered and pH of the filtrate was measured (Alakali et al. 2010) using a digital pH meter (model CP90: Century Instruments Limited, Mumbai, India).

Cooking properties

The effect of cooking on cooking yield, percent fat retention and percent moisture retention of chicken nuggets were determined using standard procedures. The cooking yield was determined as reported by Naveena et al. (2006) as follows:

$$Cooking\ Yield\ (\%) = [Weight\ of\ cooked\ nuggets / Weight\ of\ raw\ nugget] \times 100$$

Fat retention was calculated according to Murphy et al. (1975) using equation:

$$Fat\ retention\ (\%) = [Fat\ in\ cooked\ nuggets\ (\%) / Fat\ in\ raw\ nuggets\ (\%)] \times Cooking\ yield\ (\%)$$

Moisture retention was determined according to El-Magoli et al. (1996) using the following equation:

$$Moisture\ retention\ (\%) = [moisture\ in\ cooked\ nuggets\ (\%) / moisture\ in\ raw\ nuggets\ (\%)] \times Cooking\ yield\ (\%)$$

Color properties

Color measurement was carried out using a Hunter Colorimeter model 45/0-L mini scan XE PLUS (Hunter Associates Labs, Reston, VA, USA) on the basis of three

variables, namely, L, a, and b (American Meat Science Association, 1991). The instrument was calibrated against a standard black as well as white reference tiles.

The samples were placed in a transparent Petri dish and positioned directly on the light path to measure the colour parameter values of L, a and b. Four colour readings were taken from each chicken nugget sample and the average was used for analysis.

Sensory characteristics

Sensory evaluation was carried out by a 12-member panel of judges drawn from scientists and postgraduate students of Central Institute of Post Harvest Engineering and Technology who are familiar with chicken nuggets. The chicken nuggets were assessed for the appearance, flavor, saltiness, juiciness, texture, and overall acceptability using 9-point descriptive scale (Peryam and Pilgrim 1957). The sensory score of 9 was extremely desirable, whereas a score of 1 was extremely undesirable.

Statistical analysis

Data obtained from all the analyses (8 replications for proximate composition; 4 for physicochemical characteristics; 12 for sensory characteristics) were analysed by using One-Way Analysis of Variance (ANOVA) following standard procedures (Snedecor and Cochran 1989). The significant mean differences were tested as per Duncan's multiple range test (DMRT) described by Duncan (1955).

Results & discussion

Physicochemical characteristics of cooked chicken nuggets

The mean±SD values related to proximate composition of raw chicken nuggets and quality of cooked chicken nuggets as influenced by addition of fat and salt are shown in Table 1.

pH

The results show that pH of cooked chicken nuggets did not differ significantly due to added fat and salt content. A similar trend was observed in buffalo meat patties (Anjaneyulu and Sharma 1991), pH affects the water holding capacity (WHC) of meat and meat products. WHC of meat is minimal when the pH is just at the isoelectric point of meat proteins. On either side of the isoelectric point, the ionic strength could be improved steadily with adjusted pH, and thus leading to increased WHC of meat products. In the present study non-significant results were obtained for values of pH which showed that increase in the WHC and other

Table 1 Changes in proximate composition of raw chicken nuggets and quality of cooked chicken nuggets as influenced by addition of fat and salt

	T1	T2	T3	T4
Proximate composition of raw chicken nuggets (n=8)				
Fat (%)	15.5±0.77^{a}	15.5±0.75^{a}	15.4±1.11^{a}	10.7±0.98^{b}
Moisture (%)	60.8±1.69	61.6±1.23	61.2±1.57	62.4±2.02
Protein (%)	17.3±0.65^{b}	17.3±0.67^{b}	17.6±0.86^{ab}	18.5±1.13^{a}
Carbohydrates (%)	4.7±1.63^{b}	3.5±0.82^{b}	3.1±1.15^{b}	7.3±2.13^{a}
Ash (%)	1.7±0.01^{c}	2.1±0.03^{b}	2.6±0.01^{a}	1.2±0.00^{d}
Physicochemical characteristics of cooked chicken nuggets (n=4)				
pH	6.2±0.05	6.2±0.15	6.2±0.10	6.2±0.13
Cooking yield (%)	88.3±0.35^{bc}	89.3±0.36^{a}	88.9±0.50^{ab}	88.0±0.28^{c}
MR (%)	77.0±1.21^{a}	78.8±0.87^{a}	79.4±0.73^{a}	70.9±0.57^{b}
FR (%)	87.6±1.32^{a}	89.4±1.35^{a}	88.8±1.38^{a}	77.0±0.79^{b}
L (lightness)	53.9±2.25^{ab}	53.5±2.07^{ab}	55.8±1.42^{a}	51.9±0.74^{b}
a (redness)	3.9±0.24^{c}	4.4±0.23^{a}	4.3±0.14a^{b}	4.1±0.15^{bc}
b (yellowness)	23.1±0.68^{ab}	22.4±0.76^{b}	23.0±0.33^{ab}	23.8±0.31^{a}
Sensory characteristics of cooked chicken nuggets (n=12)				
Appearance	7.7±0.72^{a}	7.4±0.84^{a}	7.4±0.77^{a}	5.8±0.51^{b}
Flavour	7.4±0.92^{a}	7.4±0.94^{a}	6.8±1.30^{a}	4.3±0.75^{b}
Saltiness	7.4±0.85^{a}	6.9±1.56^{a}	5.3±2.09^{b}	2.4±0.70^{c}
Juiciness	6.8±1.07^{a}	6.9±0.79^{a}	6.9±1.47^{a}	3.6±0.72^{b}
Texture	7.4±0.74^{a}	7.0±0.78^{a}	6.9±1.49^{a}	4.9±0.57^{b}
Overall acceptability	7.6±0.91^{a}	7.8±0.94^{a}	3.8±0.70^{b}	2.3±0.85^{c}

T1=5% fat+1.5% salt; T2=5% fat+2% salt; T3=5% fat+2.5% salt; T4=No added fat and salt

Values bearing different superscript in a row differ significantly (P<0.05)

cooking properties (Table 1) were due to some other reasons.

Cooking properties

Cooking yield was significantly ($P<0.01$) higher in T2 followed by T3 and lowest in T4. The percent moisture retention and percent fat retention in T1, T2 and T3 differed significantly ($P<0.001$) from T4 and otherwise non-significant among each other. Sodium chloride plays a key role in the solubilization of myofibrillar proteins for subsequent denaturation/aggregation to give good water retention and acceptable rigidity/elasticity of the meat gels (Gordon and Barbut 1992). In the present study significant ($P<0.01$) results were observed for cooking yield between different groups which show the effect of salt in improving water holding capacity of meat products. Higher cooking yield were observed in 5% added fat at 2% salt content than other groups which received support from work of Barbut and Mittal (1992) who reported that simple reduction in the fat content of processed meat products substantially reduces cooking yield. Moisture and fat retention was also significantly ($P<0.001$) higher in added fat and salt groups. Moisture retention was higher at 2.5% salt level while fat retention was higher at 2.0% salt level; apart from this it is also obvious (Table 1) that moisture retention increased linearly between 0 and 2.5 salt contents. The addition of sodium chloride in conjunction with phosphates is a standard practice in the meat industry, whose effects on increasing the WHC and subsequently reducing drip loss and cooking loss have been investigated in numerous studies (Gordon and Barbut 1992; Martin et al. 2002; Detienne and Wicker 1999; Puolanne et al. 2001). Sheard et al. (1990) found that cooking loss was significantly reduced when UK-style grill-steaks were injected with varying amounts of tripolyphosphate and sodium chloride. Furthermore, the effects of injecting a solution including sodium lactate, phosphate, and sodium chloride on cooking loss of beef were studied by McGee et al. (2003) Compared with control samples, the injected treatments had lower ($P<0.01$) cooking and re-heating loss percentages, which showed that sodium lactate could work synergistically with phosphate and sodium chloride to further enhance their functionality.

Color properties

L, a and b values differed significantly ($P<0.05$) among all four groups, a values were significantly higher in T2 followed by T3 and T1 and lowest in T4. The 'L' value signifies the lightness (100 for white and 0 for black), the 'a' value represents greenness and redness (−80 for green and 100 for red), while the 'b' value signifies change from blueness to yellowness (−80 for blue and 70 for yellow). L, a and b values in this study differed significantly ($P<0.05$) among all four groups, redness in cooked meat products is a desirable factor for consumer preferences and in present findings a values were significantly higher in group 2 followed by group 3 and group 1 and lowest in group 4.

Sensory characteristics of cooked chicken nuggets

Mean values of appearance, flavor, saltiness, juiciness, texture and overall acceptability of cooked chicken nuggets are shown in Table 1. Incorporation of fat and salt had very significant ($P<0.001$) effect on all the sensory scores investigated. The appearance, flavor, juiciness and texture was higher in T1, T2 and T3 group than T4 but non-significant among each other however saltiness and overall acceptability scores were significantly higher ($P<0.001$) in T1 and T2 followed by T3 and lowest scores were obtained in T4.

Appearance

Appearance determines how consumers perceive quality and significantly influences purchasing behaviour. In the present investigation appearance scores for added fat and salt contents were significantly higher which may be due to higher color values and textural scores (Table 1)

Flavor

Flavour is a multi-sensory perception produced through the integration of the senses of taste, smell and the trigeminal (Auvray and Spence 2008). In the present findings flavor scores were higher in added fat and salt groups than no added fat and salt group. According to previous studies (Rabe et al. 2003; Salles 2006), NaCl is likely to increase the volatility of the most hydrophobic compound by decreasing the water molecules available for its solubilisation. Moreover, meat proteins are able to bind volatile compounds (Pérez-Juan et al. 2008) and NaCl reduces this ability by modifying the polarity of surface proteins (Ruusunen et al. 2005) and by causing protein denaturation (Pérez-Juan et al. 2008). However, fat acts as solvent for lipophilic compounds decreasing their vapour pressure (Hatchwell 1994) and thus suppressing their release. Hydrophilic volatile compounds are less affected by changes in fat content than lipophilic compounds (Hort and Cook 2007).

Saltiness

In present investigation the saltiness scores were significantly higher for T1 in respect to T2 followed by T3 and lowest in T4. These results are in accordance with above discussion that salt improves the palatability of meat and meat products by

adjusting various factors and low scores in T3 in spite of high salt contents may be due to the fact that salt is a self limiting ingredient; at high concentrations it negatively affects palatability of meat products.

Juiciness

Juiciness in cooked sausages (nuggets) is defined as the amount of moisture or juice perceived during mastication (Matulis et al. 1995; Hayes 2009) which is related to the ability of meat proteins to entrap water. In the present study the juiciness scores were significantly better in added fat and salt groups.

Similarly, Ruusunen et al. (2001) found a slight increase in juiciness with fat in bologna type sausages and in another study (Das and Rajkumar 2011) sensory analysis revealed that goat meat patties with less fat had less flavour and juicer than patties with high fat. In contrary to this, Matulis et al. (1995) and Crehan et al. (2000) reported lower juiciness scores as fat increased in frankfurters due to substitution of water by fat in high fat formulations leading to lower moisture content in these sausages. However, in the present study, moisture content of nuggets was not affected by salt content and thus the increase in juiciness due to salt must be attributed to a different factor than increase in water binding capacity.

Texture

Texture properties can affect the perceived flavour (Bayarri et al. 2006). Moreover, modifications in nugget formulations (fat and salt content) lead to differences in texture. Better textural scores in present study received support from previous results of Hand et al. (1987) who reported that reducing fat contents of meat products resulted in finer, more rubbery and less juicy products. Similarly, Desmond 2006; Saint-Eve et al. 2009 reported that salt is included to enhance product textural properties.

Overall acceptability

Overall acceptability of cooked chicken nuggets in present study was higher at 5% added fat with 2% added salt than other formulations and was lowest in no added fat and salt group which is similar to the results by Das et al. 2009 who reported that overall acceptability were higher for patties with chicken fat.

Conclusion

In conclusion, allowing for the flourishing growth of fast food industries; chicken nuggets needs to be produced in higher quantity and to reduce cost, there is increasing interest in using of various meat additives. Though, chicken fat are edible, it is important to evolve production processes for gainful utilization of this part. As shown in the present study, even up to 5% level of chicken fat with 1.5% added salt there is no adverse effect in terms of physico-chemical, proximate composition and sensory qualities of cooked chicken nuggets. Even, at this fat and salt level products were more preferred by panellist than no fat-no salt chicken nuggets.

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