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Evaluation of Coconut Water and Coconut Milk as Ice Flake Substitute in Chicken Nuggets

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ABSTRACT

Coconut products have a great role to play in the fast developing functional food sector. In this pretext, a study was carried out using tender coconut water (TCW), ripened coconut water (RCW) and coconut milk (CM) as ice flake substitute in meat emulsion. Increasing concentrations of each of this substituent, 0%, 25%, 50%, 75% and 100% was used to replace ice flakes in chicken nuggets formulation and the quality parameters were studied. Among the three treatments, the results were nearly identical for TCW and RCW, while CM addition showed most satisfactory results. In nuggets with TCW and RCW, a significant ($P<0.05$) decrease was observed in moisture and pH, while a significant increase was observed in ash content and standard plate count (SPC). A slight increase in crude protein, fat and shear force was also observed with addition of TCW and RCW. There was no statistical significance in sensory parameters except for flavour in RCW added chicken nuggets. CM added nuggets showed a statistically significant ($P<0.05$) increase in sensory scores and 100% substitution of ice flakes with CM showed highest sensory scores except for juiciness. In CM incorporated nuggets, moisture content and pH value decreased significantly ($P<0.05$) where as ash and CP content increased significantly ($P<0.05$). Moreover higher level of CM addition resulted in higher binding ability of meat emulsion. The microbiological analysis showed a non significant increase. The results showed that among three ice flakes substitutes studied, CM was found more effective in enhancing the quality of chicken nuggets.

Keywords: Coconut water, coconut milk, chicken nuggets, sensory scores.

Coconut palm (*Cocos nucifera* L.) is one of the plants with multitude of commercial applications, hence described as "Kalpavriksha". The potential uses of coconut is being gradually exploited with the advancements in processing technologies, which resulted in development of a large number of value added products suitable for current Indian market. India is one of the largest coconut producing countries in the world with a share of 15.90% in cultivation area and 21.54% in total production (Seow *et al.,*1997). Coconut fruit, popularly known as nut is made up of outer exocarp, a thick fibrous coat known as husk and inner endocarp or shell. Lining the shell is a white albuminous endosperm or 'coconut meat' and the inner cavity is filled with a clear sweet refreshing liquid called 'coconut water'.

Almost every dish in southern India utilizing coconut as an ingredient and despite being used in various traditional products there are lesser evidence of it being used as a functional ingredient in meat products formulations. Home preparation of coconut milk involves squeezing by hand of freshly grated endosperm, wrapped within a cheese cloth, to express the milk (Simuang *et al.,* 2004). It is very important ingredient for many traditional foods of Asian and Pacific regions such as curries and desserts. It can be converted into other food products such as dehydrated coconut milk (Rastogi and Raghavrao, 2006), dehydrated coconut skim milk (Hagenmaier, 1974) and canned cream (Timmins and Kramer, 1977). Coconut milk can also be used as a substitute for dairy cream in the preparation of white soft cheese and other similar food recipes (NIIR Board, 2007).

Tender coconut water (TCW), technically the liquid endosperm, is the most nutritious wholesome beverage that the nature has provided. The tender water or green coconut is consumed as refreshing drink and is popular in the world beverage market (Banzon *et al.,* 1990). Ripened coconut water (RCW) is obtained from matured nuts and its proximate composition is different from that of tender coconut water (Jean *et al.,* 2009). TCW consists of approximately 95% water and 5% solids which include 3.7% carbohydrate, 0.2% fat, 0.8% protein and 0.4% ash. RCW is characterized by a decrease in moisture content and an increase in total solid content (Jean *et al.,* 2009). Coconut water in its natural form is a refreshing and nutritious beverage which is widely consumed due to its beneficial properties to health, some of which are based on cultural/traditional beliefs (George and Sherrington, 1984; APCC, 1994; Janick *et al*., 2008; Sandhya and Rajmohan, 2008). It is also believed that coconut water could be used as an important alternative for oral rehydration and even for intravenous hydration of patients in remote geographical regions (Campbell-Falck *et al.,* 2000). Coconut water may also offer protection against myocardial infarction (Anurag and Rajmohan, 2003).

Emulsion based meat products are tasty, soft textured, convenient and rich source of protein. Ice flakes are one of the key ingredients in meat emulsion formulation, which help in extraction of salt soluble proteins and uniform distribution of polyphosphates, salt and nitrites in meat emulsion. The dispersing or mixing activity of water is highly required for fat emulsification and meat emulsion formation with other non meat ingredients. The major drawback of this particular ingredient is that, it contributes nothing to the nutritive value of meat products, hence any ice flake substitute having additional or supplementary nutritive value is of great importance in new products development. In this context, coconut water and milk owe rich nutritional value, but hardly any research was undertaken to find the effect of these on emulsion based meat products.

Therefore a study was conducted by incorporating coconut water and coconut milk as a complete or partial substitution of ice flakes in meat emulsion. In the present work, three substituents namely TCW, RCW and CM were used to replace ice flakes from the meat emulsion formulation. This particular study also aims to evaluate the effect of coconut milk and coconut water on physiochemical, microbiological and sensory properties of chicken nuggets prepared from the emulsion.

MATERIALS AND METHODS

Raw materials

Dressed chicken carcasses were procured from Central Avian Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India. Carcasses were packed in clean low density polyethylene (LDPE) bags and quickly brought to the processing plant of Livestock Products Technology division. After proper deboning, meat was packed in polyethylene bags and stored overnight at 4 ± 1 °C in a refrigerator and then frozen stored at −18 ˚C till further use. TCW and RCW were collected in sterile condition to reduce microbial load. Coconut milk was prepared by grating of coconut kernel wrapping and squeezing in a cheese cloth. Freshly prepared coconut milk contains nearly 55±3% moisture content, 37±2% fat and 8±2% protein (Simuang *et al.,* 2004). This sample was then diluted by potable water to adjust the desired fat content of 20% (Ampawan and Pawinee, 2006) then the overall composition changed to 75-70% protein, and 5-10% SNF (Table 1).

Table 1: Proximate composition (in percentage) of Tender coconut water (TCW), Ripened coconut water (RCW) and Coconut milk (CM)

Composition	Tender coconut water (TCW)	Ripened coconut water (RCW)	Coconut milk (CM)
Moisture (%)	94.89 ± 0.06	94.03 ± 0.12	74.53 ± 0.41
Crude Protein (%)	0.74 ± 0.02	0.51 ± 0.02	2.06 ± 0.04
Fat (%)	0.24 ± 0.03	0.16 ± 0.02	20.08 ± 0.08
Total ash (%)	**0.45 ± 0.05**	**0.63 ± 0.05**	**1.09 ± 0.02**

*TCW is tender coconut water, RCW is ripened coconut water and CM is coconut milk.

Preparation of chicken nuggets

Three different meat batters were prepared at different times which include replacement of ice flakes with increasing concentration of tender coconut water (TCW), ripened coconut water (RCW) and coconut milk (CM) respectively. The specific solutions of TCW, RCW and

Table 2: Formulation of ingredients followed for the preparation of both control and treatment nuggets (g/Kg)

Ingredients (gkg^{-1})	Control	T1	T2	T3	T4	R1	R2	R3	R4	C1	C2	C3	C4
Lean meat	700	700	700	700	700	700	700	700	700	700	700	700	700
Ice flakes	100	75	50	25	—	75	50	25	—	75	50	25	—
TCW	—	25	50	75	100	—	—	—	—	—	—	—	—
RCW	—	—	—	—	—	25	50	75	100	—	—	—	—
CM	—	—	—	—	—	—	—	—	—	25	50	75	100
Refined oil	80	80	80	80	80	80	80	80	80	80	80	80	80
Refined wheat flour	50	50	50	50	50	50	50	50	50	50	50	50	50
Condiment mix	35	35	35	35	35	35	35	35	35	35	35	35	35
Sodium chloride	18	18	18	18	18	18	18	18	18	18	18	18	18
Spice mix	12	12	12	12	12	12	12	12	12	12	12	12	12
Sod. Hexametaphosphate	5	5	5	5	5	5	5	5	5	5	5	5	5
Sodium nitrite	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

*(T1-T4 represents nuggets in which ice flake was substituted by TCW at 25, 50, 75 & 100 %, R1-R4 represents nuggets in which ice flake was substituted by RCW at 25, 50, 75 & 100 % and C1-C4 represents nuggets in which ice flake was substituted by CM at 25, 50, 75 & 100 %.)

CM was substituted in each batter at 0%, 25%, 50%, 75%, and 100% (Table 2) of the ice flakes, after being cooled to-1°C . A control group of nuggets were also prepared following same procedure but without substituting ice flakes in the formulation. In the processing of chicken nuggets deboned lean chicken was minced first, then salt, polyphosphate, nitrite, condiments, and any one particular substitute of ice flake were added and chopped in bowl chopper for 1-2 min. Following this, refined vegetable oil was added and chopped till oily appearance disappeared. Then refined wheat flour and spice mix was added and chopped for 1-2 min. After this, batter was stuffed in a stainless steel box smeared with oil inside and steam cooked for 45 min. Chicken meat blocks so obtained were cooled, sliced and cut into pieces to get nuggets.

Sensory evaluation

Sensory evaluation of various samples were conducted using an 8 point descriptive scale (Keeton, 1983), where 8 = excellent and 1 = extremely poor. The sensory panel consisted of ten members selected from scientists and post graduate students of the division of Livestock Products Technology with age between 28–45 years. The panelists were explained about the nature of experiments without disclosing the identity of samples and were asked to rate their preference on 8 point descriptive scale. Samples were warmed in a microwave oven for 1 min. Water was provided to rinse mouth between the samples. The panelists judged the samples for general appearance, binding, color, flavor, juiciness, and overall acceptability.

Statistical analysis

Three trails were conducted for each experiment with duplicate samples. The data generated for different quality characteristics were compiled and analyzed using SPSS (version 20 for Windows; SPSS, Chicago, USA) with randomized block design and subjected to analysis of variance (Snedecor and Cochran, 1995).

RESULTS AND DISCUSSION

Physico-chemical, microbiological and sensory quality parameters of TCW incorporated chicken nuggets

Slight variation was detected in proximate composition between the treatments and between control and treatment nuggets. Numerically an increase in protein content, fat content, shear force value and ash content and a decrease in moisture content and pH were observed with increasing concentration of TCW in chicken nuggets (Table 3). But no significant ($P>0.05$) differences were noted in protein

Table 3: Physico-chemical and microbiological parameters of TCW incorporated chicken nuggets

Parameters	Control	T1	T2	T3	T4
Moisture (%)	65.10 ± 0.37^{a}	64.48 ± 0.40^{ab}	63.57 ± 0.26^{b}	62.31 ± 0.27^{c}	62.07 ± 0.20^{c}
CP (%)	18.39 ± 0.11	18.45 ± 0.12	18.57 ± 0.16	18.66 ± 0.17	18.69 ± 0.10
Fat (%)	8.64 ± 0.19	8.70 ± 0.15	8.71 ± 0.13	8.73 ± 0.12	8.76 ± 0.09
Ash (%)	2.10 ± 0.04^{b}	2.10 ± 0.04^{b}	2.13 ± 0.04 ^{b}	2.15 ± 0.04 ^{a}	2.19 ± 0.06 ^{a}
Shear force(kg/cm^2)	0.37 ± 0.02	0.41 ± 0.03	0.42 ± 0.02	0.44 ± 0.01	0.44 ± 0.03
pH	6.46 ± 0.00 ^{a}	6.37 ± 0.03 ^{b}	6.34 ± 0.01 ^{b}	6.32 ± 0.01 ^{b}	6.31 ± 0.02 ^{b}
SPC (log cfu/g)	1.92 ± 0.01 ^{d}	1.93 ± 0.01 ^{cd}	1.95 ± 0.01 ^{bc}	1.96 ± 0.01 ^{ab}	1.98 ± 0.01 ^{a}

*T1-T4 represents nuggets in which ice flake was substituted by TCW at 25, 50, 75 & 100 %. Means with different superscripts (letters row wise) indicates statistical significance P < 0.05.

Table 4: Sensory analysis scores of TCW incorporated chicken nuggets

Parameters	Control	T1	T2	T3	T4
Appearance	6.97 ± 0.27	7.03 ± 0.24	6.98 ± 0.28	6.97 ± 0.27	6.98 ± 0.24
Color	6.97 ± 0.27	6.90 ± 0.23	6.87 ± 0.22	6.82 ± 0.21	6.74 ± 0.17
Flavor	6.92 ± 0.15	7.15 ± 0.10	7.05 ± 0.05	7.05 ± 0.14	6.90 ± 0.13
Juiciness	7.02 ± 0.06	7.0 ± 0.00	6.95 ± 0.03	6.90 ± 0.06	6.90 ± 0.08
Binding	6.93 ± 0.04	7.0 ± 0.04	7.03 ± 0.27	7.10 ± 0.18	7.15 ± 0.07
Overall acceptability	7.05 ± 0.02	6.94 ± 0.22	6.94 ± 0.25	6.99 ± 0.22	7.09 ± 0.12

*T1-T4 represents nuggets in which ice flake was substituted by TCW at 25, 50, 75 & 100 %. Means with different superscripts (letters row wise) indicates statistical significance P < 0.05.

Table 5: Physico-chemical and microbiological properties of RCW incorporated chicken nuggets

Parameters	Control	R1	R2	R3	R4
Moisture (%)	65.33 ±0.24 ^{a}	64.31 ± 0.25 ^{b}	64.14 ± 0.03 ^{b}	63.54 ± 0.08 ^{c}	63.15 ± 0.08 ^{c}
CP (%)	18.10 ±0.22	18.12 ± 0.05	18.26 ± 0.12	18.34 ± 0.11	18.34 ± 0.11
Fat (%)	8.59 ± 0.16	8.63 ± 0.16	8.74 ± 0.30	8.75 ± 0.05	8.83 ± 0.15
Ash (%)	2.15 ± 0.11 ^{b}	2.21 ± 0.06 ^{b}	2.37 ± 0.03 ^{b}	2.60 ± 0.04 ^{a}	2.67 ± 0.06^{a}
Shear force (kg/cm^2)	0.38 ± 0.04	0.50 ± 0.03	0.50 ± 0.02	0.50 ± 0.10	0.52 ± 0.03
pH	6.43 ± 0.03 ^{a}	6.32 ± 0.01 ^{b}	6.32 ± 0.02 ^{b}	6.26 ± 0.03 ^{bc}	6.22 ± 0.02 ^{c}
SPC(log cfu/g)	1.88 ± 0.01 ^{b}	1.92 ± 0.01 ^{ab}	1.94 ± 0.01 ^{ab}	1.97 ± 0.01 ^{a}	1.97 ± s0.01 ^{a}

*R1-R4 represents nuggets in which ice flake was substituted by RCW at 25, 50, 75 & 100 % . Means with different superscripts (letters row wise) indicates statistical significance P < 0.05).

content, fat content and shear force value between different samples. A significantly ($P < 0.05$) lower moisture content and pH value were observed with increasing concentration of TCW compared to control nuggets. A significantly ($P < 0.05$) higher total ash content was also seen with increasing concentration of TCW substitution. The microbiological study revealed that there was a significant increase (P<0.05) in the SPC with increasing concentration of TCW substitution in chicken nuggets.

Both the control and the TCW added chicken nuggets generally had a desirable whitish brown color. The binding

ability of the treatment nuggets were excellent and were increasing non significantly ($P > 0.05$) with increasing concentration of TCW substitution. The present study indicated no significant ($P > 0.05$) differences between treatments for appearance, binding, color, flavor, juiciness and overall acceptability (Table 4).

Physico-chemical, microbiological and sensory quality parameters of RCW incorporated chicken nuggets

The proximate composition of nuggets, in which ice-flake was substituted by RCW, varied slightly between the treatments. A significant ($P < 0.05$) decrease was seen in moisture content and pH in RCW incorporated nuggets compared to control. The fat content, shear force value and crude protein content increased numerically with increasing concentration of RCW substitution, but the increase was non-significant. A significant ($P < 0.05$) increase in total ash content was also observed at higher level of RCW incorporation in nuggets (Table 5). The microbiological study revealed that there was a significant ($P < 0.05$) increase in SPC value at higher level of RCW incorporation.

Chicken nuggets added with RCW had an acceptable whitish brown color. The sensory analysis of the nuggets indicated no significant ($P > 0.05$) difference in appearance, binding, color, juiciness and overall acceptability. However a statistically significant ($P < 0.05$) decrease in flavor scores was observed with increasing concentration of RCW in chicken nuggets (Table 6).

Physico-chemical, microbiological and sensory quality parameters of CM incorporated chicken nuggets

Among the three ice flake substitutes, coconut milk incorporation in chicken nuggets showed most variable results. Numerically an increase in ash content, crude protein content, fat content and shear force value and a decrease in moisture content and pH value was observed in nuggets with increasing CM substitution. All results were significantly ($P < 0.05$) different between the treatments and control nuggets (Table 7). Changes in SPC value of chicken nuggets associated with CM incorporation was found to be non significant compared to control nuggets.

Table 6: Sensory analysis scores of RCW incorporated chicken nuggets

Parameters	Control	R1	R2	R3	R4
Appearance	7.05 ± 0.05	6.89 ± 0.09	6.93 ± 0.09	6.96 ± 0.10	7.02 ± 0.02
Color	6.92 ± 0.08	6.92 ± 0.08	6.83 ± 0.09	6.75 ± 0.13	6.70 ± 0.04
Flavor	7.13 ± 0.07^{a}	6.97 ± 0.07 ^{ab}	6.93 ± 0.08 ^{b}	6.83 ± 0.06 ^{b}	6.80 ± 0.04 ^{b}
Juiciness	7.02 ± 0.06	7.00 ± 0.00	6.95 ± 0.03	6.93 ± 0.06	6.90 ± 0.08
Binding	6.88 ± 0.12	6.98 ± 0.14	7.03 ± 0.08	7.08 ± 0.12	7.18 ± 0.05
Overall Acceptability	7.04 ± 0.04	6.99 ± 0.11	6.97 ± 0.11	6.88 ± 0.22	6.73 ± 0.22

*R1-R4 represents nuggets in which ice flake was substituted by RCW at 25, 50, 75 & 100 %. Means with different superscripts (letters row wise) indicates statistical significance $P < 0.05$.

Table 7: Physico-chemical and microbiological properties of CM incorporated chicken nuggets

Parameters	Control	C1	C2	C3	C4
Moisture (%)	65.36± .26 ^{a}	63.87 ± 0.27 ^{b}	62.58 ± 0.39 ^{c}	61.74 ± 0.47 ^{cd}	61.36 ± 0.15 ^{d}
CP (%)	18.10±.10 ^{b}	18.88 ± 0.24^{a}	19.03 ± 0.27 ^{a}	19.13 ± 0.13 ^{a}	19.49 ± 0.23 ^{a}
Fat (%)	8.74 ± 0.13 ^{d}	9.18 ± 0.13 ^{cd}	9.26 ± 0.13 ^{c}	9.81 ± 0.14 ^{b}	10.59 ± 0.15 ^{a}
Ash (%)	1.97 ± 0.03 ^{d}	2.53 ± 0.04 ^{c}	2.95 ± 0.05 ^{b}	2.98 ± 0.05 ^{b}	3.39 ± 0.06 ^{a}
Shearforce (kg/cm^2)	0.37 ± 0.02 ^{d}	0.48 ± 0.03 ^{c}	0.54 ± 0.02 ^{c}	0.56 ± 0.02 ^{ab}	0.61 ± 0.01 ^{a}
pH	6.48 ± 0.09 ^{a}	6.43 ± 0.09 ^{b}	6.40 ± 0.00 ^{b}	6.33 ± 0.03 ^{bc}	6.31 ± 0.01 ^{c}
SPC(log cfu)	1.94 ± 0.01	1.92 ± 0.01	1.96 ± 0.01	1.98 ± 0.01	1.98 ± 0.01

*(C1-C4 represents nuggets in which ice flake was substituted by CM at 25, 50, 75 & 100 %. . Means with different superscripts (letters row wise) indicates statistical significance $P < 0.05$).

Table 8: Sensory analysis scores of CM incorporated chicken nuggets

Parameters	Control	C1	C2	C3	C4
Appearance	7.02 ± 0.24	7.18 ± 0.09	7.27 ± 0.09	7.3 ± 0.07	7.34 ± 0.08
Color	7.10 ± 0.28	7.08 ± 0.27	7.03 ± 0.27	6.95 ± 0.26	6.88 ± 0.08
Flavor	6.8 ± 0.06 ^{b}	7.04 ± 0.10 ^{ab}	7.06 ± 0.05 ^{ab}	7.12 ± 0.10 ^{ab}	7.15 ± 0.06 ^{a}
Juiciness	7.22 ± 0.11 ^{a}	7.05 ± 0.07 ^{ab}	6.90 ± 0.04 ^{bc}	6.83 ± 0.03 ^{c}	6.62 ± 0.03 ^{d}
Binding	6.87 ± 0.11 ^{b}	7.10 ± 0.06 ^{a}	7.20 ± 0.10 ^{a}	7.25 ± 0.04 ^{a}	7.31 ± 0.03 ^{a}
Overall Acceptability	6.96 ± 0.03 ^{b}	7.02 ± 0.02 ^{ab}	7.08 ± 0.08 ^{ab}	7.12 ± 0.04 ^{ab}	7.18 ± 0.03 ^{a}

*(C1-C4 represents nuggets in which ice flake was substituted by CM at 25, 50, 75 & 100 %. Means with different superscripts (letters row wise) indicates statistical significance $P < 0.05$).

The sensory analysis showed variable results. No significant ($P > 0.05$) differences were observed for appearance and color scores after CM incorporation. But binding, flavor and overall acceptability increased significantly ($P < 0.05$). Decreased juiciness scores were observed at higher level of CM incorporation and that might be due to the decreased moisture content in CM (Table 8). Overall 100% substitution of ice flakes with CM showed highest sensory scores including overall acceptability except for juiciness scores.

Higher values of protein content and fat content noticed in chicken nuggets after TCW incorporation might be due to higher concentration of protein and fat in coconut water. Mohapatra *et al*. (2013) utilized whey as ice flake substitute in chevon nuggets and found that inclusion of whey resulted in decrease in moisture and pH while an increase in protein and fat content of nuggets. Similarly change in rheological properties and water holding capacity of poultry meat batter was reported after inclusion of preheated whey protein (Hongsprabhas and Barbut, 1999). The significant ($P < 0.05$) decrease in moisture content at higher level of TCW substitution might be due to higher total solid content and similarly the reduced pH value might be due to lower pH of tender coconut water. And higher mineral content of TCW might be the reason for more ash content in nuggets incorporated with TCW. The slight increase observed for SPC value after coconut water inclusion might be due to the abundant supply of sugar from coconut water for bacterial metabolism. The significant decrease in flavor score of nuggets incorporated with RCW might be attributed to the slight sour taste of ripened coconut water. And the significant increase ($P < 0.05$) in fat content of nuggets incorporated with CM might be due to increased fat content in CM, which was previously standardized at 20% fat level. A significant increase in shear force value of nuggets after CM incorporation might be due to enhanced emulsifying capacity of the coconut milk. An increase in the emulsifying capacity of ice cream mix was reported when coconut milk was used as a fat replacer (Ines-Aparecida *et al.,* 2011).

CONCLUSION

Nuggets incorporated with CM have the most desirable sensory properties and increasing level of CM substitution improves binding ability and protein content of nuggets. Nuggets incorporated with TCW and RCW has similar proximate and sensory scores except for moisture content and pH value. Whereas microbial count for CM incorporated nugget was lowest compared to TCW and RCW incorporation. The experiment showed that TCW, RCW and CM can be utilized as a functional ingredient to fortify processed meat products, hence to exploit the nutritional advantage of coconut. From the current study, it can be concluded that CM is the best substitute for ice flake in chicken meat emulsion formulation among the three substitutes studied.

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