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Extension of shelf life, sensory and quality attributes of chicken products by citrus and acacia honey coating

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Abstract: The antioxidative and antimicrobial effects of honey species and their related products were evaluated by coating chicken nuggets for sensory, quality and preservation effects. Honey samples of citrus and acacia honey were analyzed to judge the more nutritious ones. The Control treatment was designed with no addition of any preservative. Both honey treatments were prepared by adding 2g, 3g and 4g in 30g chicken nuggets after the frying process. Sensory and quality evaluation of all treatments of chicken nuggets was made at four stages (0, 7, 15, 21 and 28) from 0 day to 28 days. The results showed that both honey possessed comparable compositional differences where citrus honey exhibited more values of glucose (31.12%), diastase activity (15.75), reducing sugar (68.32%), Proline contents (203.8mg/kg), total soluble solids (125.7 brix) and electrical conductivity (0.45ms/cm) as compared to acacia honey. In contrast the acacia honey showed more ash (0.23%), pH (4.03), refractive index (1.47) sucrose (2.34%) and fructose (41.43%) values as compared to citrus honey. Citrus honey unveiled the best results in both expert and consumer-based sensory evaluation trails of chicken nuggets at the rate of 2g and 3g per 30g of nuggets. Furthermore, chemical analysis for moisture, protein, fat, ash, peroxide value, pH and TBARS showed reduction with the increment of both honey quantitties while microbial analysis presented citrus honey (3g/30g chicken nuggets) most effective against total viable count, coliform count, yeast and mold count. Results suggested that both honey types are effective in sensory, quality and storage evaluation of chicken nuggets whereas citrus honey with more noticeable results. Keeping in-view, the natural product with admirable nutritional and preservative properties can be recommended to use in chicken nuggets for more valuable and safe food product for long time.

Keywords: Shelf Life , Sensory , Chicken products

1. Introduction

Historical background of honey showed that the natural product was being used from ancient times not only as folk medicine and food but also in other food products as ingredient or preservative. Healing property of honey and diabetes was the most important factors to use as medicine from long past. Whereas honey use in winter as a food provides a healing effect to body was being practiced for a long time. Use in various foods as a preservative as well as ingredients such as syrups and other sweet products as its physical characteristics acceptable in culinary work (Szweda, 2017; Machado et al., 2018).

Honey has also been used in hams with salt-cured or bacons or to mask the high level of saltiness. In addition to that honey use in barbeque and meat sauces imparts color, flavor, and caramelization. Ready-to-eat meat products have a short shelf life because of the changes in color, flavor and bacterial load due to oxidation and more moisture level with favorite conditions of microbial growth as high-risk food. Mundo et al., 2004; Alnaqdy et al., 2005).

Chicken nugget has gained the status of conventional food in last few decades because its consumption level increased tremendously from 28 kg in 1991 to 35 kg in 2000 per person per year. Chicken nugget was coated with many food additives and ingredients for various purposes. Recently, the interest healthy foods have obviously increased consumption of such low fat foods (Khaldoun, 2002).

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Honey posed positive and valuable nutritional effects on quality parameters of on chicken, beef and turkey meat. In some research honey use with 15% (wt/wt) slows down lipid oxidation in prepared beef patties compared to patties without honey. Honey use with other process parameters was found to be unaffected in most cases (Antony et al., 2000).

The development of oxidative reactions off-flavors in poultry meat products is most common and results in rancid flavor and spoilage. Various strategies of minimizing off-flavor have been evaluated and honey which a natural food is found best for this purpose because of the presence of unique functional attributes such as antioxidant and antimicrobial activities. This present research work was planned to test the coating of Unifloral honey to chicken nuggets after processing to evaluate product safety status by applying the different type of unifloral honey and retard the production of oxidation products related to off-flavor to improve shelf life and flavor.

2. Materials And Methods

Procurement and storage of raw materials

Both citrus honey and acacia honey samples were purchased from National Agriculture Research Center (NARC) Islamabad. While chicken meat was collected from the local market of Faisalabad with the utmost care from the selected hygienic shop. Other ingredients were purchased from local market of Faisalabad for the product development. The chicken meat was minced first and then stored at proper refrigeration temperature (40C) by packing in airtight plastic bags for product development after short time of other ingredients preparation. Honey samples were stored at room temperature in sealed packaging.

Preparation of Chicken nuggets

Minced chicken meat emulsion was prepared in Sirman Bowl Chopper (Model C9VV). Refined vegetable oil, condiments, spice mixture, and other ingredients were added and mixed. Molding was performed manually with utmost care. Frying was done in fresh oil until the desired final product. Final product was then presented for the designed treatments plan. There were six treatments which are shown in table 1. The final product was wrapped in aluminum foil, packed and allowed to cool down in refrigerator storage for storage studies of nuggets while the fresh product was served to the sensory evaluation panel.

Table 1 :Treatments of chicken nuggets

Sr. No	Code of treatment	Component applied	Quantity of component applied
1	T_0	Control	---
2	T_1	Citrus honey	2g
3	T_2	Citrus honey	3g
4	T_3	Citrus honey	4g
5	T_4	Acacia honey	2g
6	T_5	Acacia honey	3g
7	T_6	Acacia honey	4g

Physicochemical Composition of honey

In all samples, nine physicochemical parameters were determined. Water mass fraction (moisture) was determined through refractometer using the AOAC Official Methods (AOAC, 2006). Electrical conductivity was measured by conductivity meter, according to the method proposed by the International Honey Commision (IHC) (IHC, 2002). Total reducing sugar mass fraction, sucrose mass fraction, acidity and ash mass fraction will be measured conformant to the AOAC Official Methods (AOAC, 2006). The pH value of honey samples was evaluated by using digital pH meter (Model pH 212) and the method suggested by the Kinati et al. 2011.

Glucose, fructose, and sucrose in honey samples were determined by using a method adopted by (Kamal el al., 2011). Reagents and standards were prepared HPLC grade and the procedure of HPLC working was followed to determine the sugar contents of honey samples.

Brix grade was determined by using Abbe refractometer using a method that was adopted by Ajani (2009).Diastase, invertase activity and proline mass fraction was determined using the methods proposed by the International Honey Commision IHC (IHC, 2002).

Physico-chemical and technological properties of Chicken Nuggets

The color of chicken nuggets was measured using a spectro-colorimeter (tristimulus color machine) with CIE lab color scale (Hunter, Lab Scan XE, Reston VA.) calibrated with a white standard tile of Hunter Lab color standard (LXNO. 16379): X= 77.26, Y= 81.94 and Z= 88.14 (L =92.71; a= -0.89; b= -0.18) by using Hunter-scofield's

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equation (Hunter, 1975). The Hue angle (t-1g b/a) and saturation index (√a2+b2) were calculated. pH Measurement, Total soluble solids (TSS) according to A.O.A.C (2005). Determination of water holding capacity (WHC) according to (Pipek et al ., 1999).

Proximate chemical analysis (moisture, protein, fat, and ash contents) chicken nuggets was estimated according to A.O.A.C. (2005). Determination of Thio Bariatric acid (TBA) Values were determined according to (Tarladgis et al., 1960). The peroxide value (PV) is the number that expresses in milli equivalents of active oxygen representing of peroxide content in 1000 g of the substance, as determined by the methods according to Nanjing University of Traditional Chinese Medicine "Njutcm" (2005).

Microbiological assessment of chicken samples

The total count of aerobic mesophilic bacteria was enumerated using standard plate count agar according to Capita et al., (2002). Isolation of Staphylococcus spp. and E. coli was attempted (Finegold and Martin,1982). For counting coliform bacteria the method suggested by the Bohaychuk et al., (2009) was adopted. Coliform group including Escherichia coli is considered an indicator of microbiological quality. On the other hand, mannitol salt agar plates were checked after 24-48 h of incubation for detection of Staphylococcus spp. The circular, smooth colonies (2-3 mm) was Gram-stained and picked up and inoculated in Mannitol salt agar. Collee et al., 1996. Microbial count per gram of chicken meat nuggets at refrigerated temperature was estimated as per the procedure recommended by Chestnut et al., (1977).

Yeast and Mold counts were estimated by using agar of potato dextrose were used and incubation at 37°C temperature for 35 hours. Colonies were counted manually and results were expressed as log CFU/g of given sample.

Sensory characteristics (juiciness, tenderness, odor, sweetness, sweetness acceptability, and flavor acceptability) of chicken meat products were evaluated by 10 trained panelists from food technology department, national research centre. The samples were sliced and placed on a tray in coded containers. The samples were evaluated at the next day of production (Antony et al., 2006).

Sample	Moisture (%)	pH	Ash (%)	Glucose (%)	Sucrose (%)	Fructose (%)	Reducing Sugar (%)
H Citrus	15.79±1.92	3.49±0.33	0.07±0.15	31.12±5.63	1.13±1.49	38.73±2.11	68.32±6.31
H Acacia	17.56±0.63	4.03±0.35	0.23±0.14	28.17±1.68	2.34±1.41	41.43±1.25	63.23±3.48
Sample	Refractive index	Water-insoluble fraction (%,w/w)	Proline content	Electrical conductivity		Total soluble solids	Diastase activity (DN)
H Citrus	1.43±0.15	13.54±18.24	203.8±121.53	0.45±5.29		125.7±99.22	15.75±7.34
H Acacia	1.47±0.11	13.82±17.14	135.81±73.41	0.25±5.81		123.3±92.11	15.31±5.12

The statistical analysis was carried out using SPSS, PS statistical software (version 11.0 SPSS Inc., Chicago,USA).The results were expressed as (mean±SE). Data were analyzed by one way analysis of variance (ANOVA). The difference between means was test for significance at ($p<0.05$) using Duncan test (Paura and Arhipova, 2002).

3. Results And Discussion

Chemical analysis of honey

Honey is complex food and its composition varies depending on source of production, geographical area, season and time of harvesting. Significant correlations of (p-value<0.05) exist between total sugar and pH, between Proline and free fatty acids, conductivity and fructose, between solids and lactic acid, invertase, between water and total sugar and aw, between Proline and diastase, sucrose, between fructose and solids, which are parameters well known as proof of botanical origin for honeys. In addition to this the water activity

is variable parameter rarely defined as discriminated for the different honey types (Serrano et al., 2004; Barhate et al., 2003).

Electrical conductivity of the honey is one of the physical property which further affected by the presence of acids and minerals in honey. While in case of glucose, reducing sugars or fructose presence remain in range of 60g/100g and further affected by the factors of honey. Carbohydrates being major ingredients are major quality determination parameters of honey. Intensity of heating of honey during processing and the storage is determined by diastase activity. (Barhate et al., 2003; Vahci et al., 2009; Karabournioti et al., 2001; Sera et al., 2000; spano et al., 2006 and Cervantes et al., 2000).

Mean moisture percentage of citrus honey evaluated in research was 15.79±1.92 while for acacia honey recorded mean moisture content was 17.56±0.63 (Table 02). The result findings of this project are comparable with the findings of (Serrano et al., 2004 and Ahmad et al., 2017).

Mean ash of citrus honey evaluated in research was 0.07±0.15while for acacia honey recorded mean ash content was 0.23±0.14 (Table 02). These results findings are in agreement with the findings of our research work (Ursulin et al., 2017 and Rodriguez et al., 2010).

Mean pH of citrus honey evaluated in research was 3.49±0.33 while for acacia honey recorded mean pH value was 4.03±0.35 (Table 02). These results findings are in agreement with the findings of our research work (Madas et al., 2014 and Castro et al., 2008).

Mean glucose percentage of citrus honey evaluated in research was 31.12±5.63 while for acacia honey recorded mean glucose percentage was 28.17±1.68 (Table 02). These results findings are in agreement with the findings of our research work (El-Sohaimy et al., 2015 and Marghitas et al., 2010).

Table 02: Chemical analysis data of citrus and acacia honey

The Mean sucrose percentage of citrus honey evaluated in the research was 1.13±1.49 while for acacia honey recorded mean sucrose percentage was 2.34±1.41 (Table 02). These results are in agreement with the findings of our research work (Ahmad et al., 2017).

The Mean fructose percentage of citrus honey evaluated in research was 38.73±2.11 while for acacia honey recorded mean fructose percentage was 41.43±1.25 (Table 02). These results findings are in agreement with the findings of our research work (Ursulin et al., 2017 and Rodriguez et al., 2010).

The Mean reducing sugar percentage of citrus honey evaluated in research was 68.32±6.31while for acacia honey recorded mean reducing sugar percentage was 63.23±3.48 (Table 02). These results findings are in agreement with the findings of our research work (Castro et al., 2008; El-Sohaimy et al., 2015).

The Mean refractive index of citrus honey evaluated in research was 1.43±0.15 while for acacia honey recorded mean refractive index was 1.47±0.11 (Table 02). These results findings are in agreement with the findings of our research work (Madas et al., 2014).

The Mean water-insoluble fractions of citrus honey evaluated in research were13.54±18.24 while for acacia honey recorded mean water insoluble fractions was 13.82±17.14 (Table 02). These results findings are in agreement with the findings of our research work (Ursulin et al., 2017 and Rodriguez et al., 2010).

Mean Proline content of citrus honey evaluated in the research was 203.8±121.53 while for acacia honey recorded mean Proline content was 135.81±73.41 (Table 02). These results findings are in agreement with the findings of our research work (Ahmad et al., 2017).

The Mean diastase activity of citrus honey evaluated in research was 15.75±7.34 while for acacia honey recorded mean diastase activity was 15.31±5.12 (Table 02). These results findings are in agreement with the findings of our research work (Marghitas et al., 2010 and El-Sohaimy et al., 2015).

The Mean electrical conductivity of citrus honey evaluated in research was 0.45±5.29 while for acacia honey recorded mean electrical conductivity was 0.25±5.81 (Table 02). These results findings are in agreement with the findings of our research work (Ursulin et al., 2017).

Mean total soluble solids of citrus honey evaluated in the research was 125.7±99.22 while for acacia honey recorded mean total soluble solids was 123.3±92.11 (Table 02). These results findings are in agreement with the findings of our research work (Madas et al., 2014 and Castro et al., 2008).

Chemical analysis of chicken nuggets

Proximate components of chicken nuggets are primary parameters to check the quality of products. Moisture, which is the basic component for microbial growth and all other reactions in foods, is major thing to be considered (Serrano et al., 2004). Fat, protein and ash are also used to meaure here in this project.

The chemical composition of chicken nuggets as affected by the addition different levels of honey and

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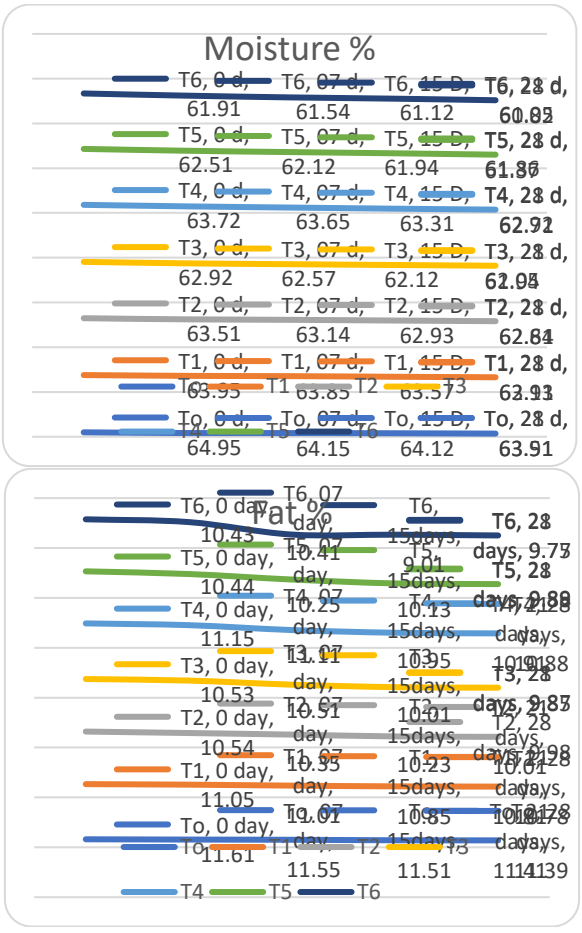
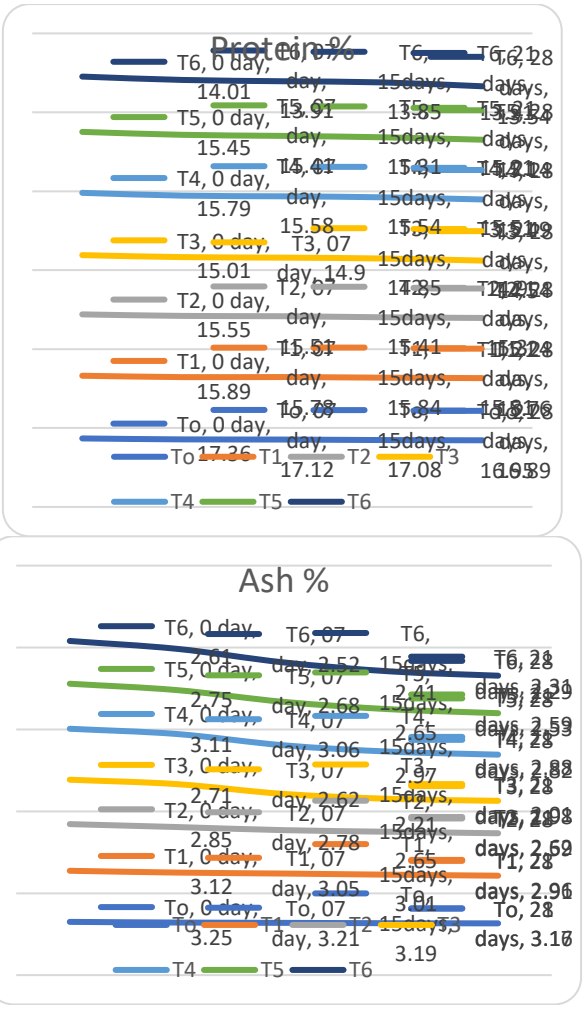
Stored for 28 days at 40Cwere determined. Data in Fig. (01) Represented that the control sample (T0) has the highest content of moisture, fat, protein and ash compared to all samples (64.95, 11.61, 17.36 and 3.25 respectively). By increasing honey concentration level moisture, protein, fat and ash content were decreased. Sample with 4g honey (T6) showed the lowest moisture, fat, protein and ash content compared to all samples (61.82, 10.55, 14.54 and 2.51 respectively). During storage there were no noticeable changes in chemical composition. There was no significant difference on chemical composition for both honey types. The findings of research are in agreement with the findings of our research work (Grumbles et al., 2008; Kim et al., 2015; Perlo et al., 2006 and Kumar et al., 2013).

Figure 1: Gross chemical composition% of chicken nuggets as affected addition different levels of honey and stored for 28 days.

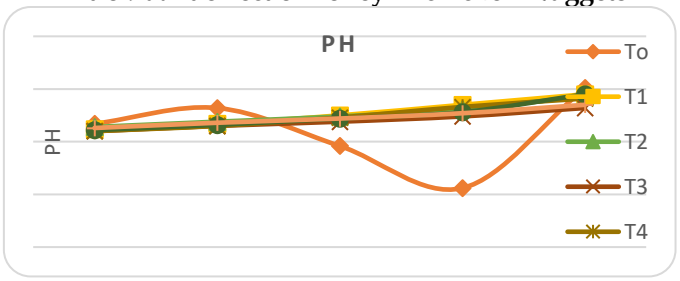




Quality analysis of chicken nuggets

The pH values of chicken nuggets samples as affected by addition different levels of honey and stored for 28 days at 4oC were measured. Data presented in Fig. (2)Showed no specific trend in the pH values during storage, with time however the control sample showed instability of pH values during storage. At day 0 maximum mean for pH of chicken nuggets was recorded in T0 (6.17±0.03) while minimum mean was evaluated in T3 (6.10±0.02). Furthermore pH level was recorded maximum mean after 28 days of storage for T0 (6.51±0.03) and while mean minimum for T3 (6.32±0.05) (Table 15). Results of this research project are comparable with the findings of (Grumbles et al., 2008; Kim et al., 2015; Biswas et al., 2006 and Barhate et al., 2003).

Antioxidant effect of honey in chicken Nuggets



Results in Fig. 3 showed that increasing honey concentration almost decreased the formation of TBA (Thiobarbituric acid value). Data showed that nuggets having honey 4g had almost the lowest values of TBA at the end of 28 days of storage. Control sample had the highest values of TBA during storage. At day 0 maximum value for TBARS of chicken nuggets was recorded in T5 (0.22±0.18) while minimum mean was evaluated in T6 (0.14±0.17). Furthermore TBARS level was recorded maximum mean after 28 days of storage for T0 (2.01±0.08) and while mean minimum for T3(1.13±1.13).These results showed samples incorporated with Citrus Honey were found effective more than samples incorporated with Acacia Honey. Moreover, both Honeys were found

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effective compared to control sample during 28 days storage at 40C.These results showed that the citrus honey found effective on TBARS as increased less than all treatments during storage. Results of this research project are comparable with the findings of (Grumbles et al., 2008; Kim et al., 2015; Perlo et al., 2006 and Kumar et al., 2015).

Figure 2: The changes of pH of chicken nuggets as affected by addition different levels of honey and stored at 40C for 28 days of storage.

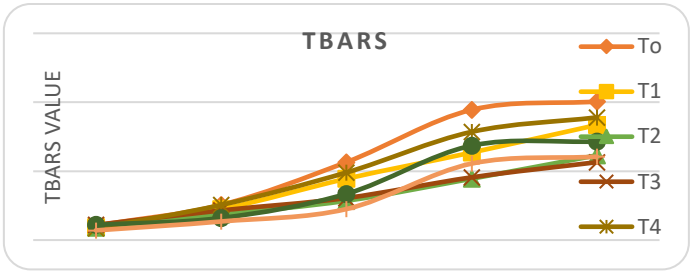
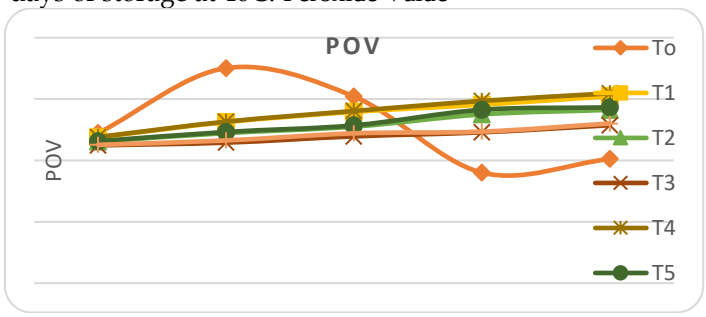


Figure 3: TBA value (mg malonaldahyde/1000g sample) of chicken nuggets as affected by addition different levels of honey during 28 days of storage at 40C. Peroxide Value



Data in Fig. 4 showed that peroxide values of all investigated samples were increased during 28 daysof storage. However the control sample showed the highest peroxide value in seven days of storage decreases inthe third week. Such decrease could be due to transformation of peroxides to malonaldehydes. At day 0 maximum Peroxide value of chicken nuggets was recorded in T0 (12.23±1.12) while minimum mean was evaluated in T3 (11.23±1.32). Furthermore Peroxide value was recorded maximum mean after 28 days of storage for T4 (15.47±1.84) and while mean minimum for T0 (10.12±1.78) (Table 17). These results showed that the Peroxide value of T0 was highest at fresh stage and after 28 days storage while that of T6 was lowest. Moreover the Peroxide value decreased in all treatments with passage of time during storage. Peroxide values for samples incorporated with Citrus Honey were less than samples incorporated with Acacia Honey. Moreover, both Honeys were found effective against oxidation compared to control sample during 28 days storage at 40C. Results of this research project are comparable with the findings of (Perlo et al., 2006 and Kumar et al., 2015; Biswas et al., 2006 and Barhate et al., 2003).

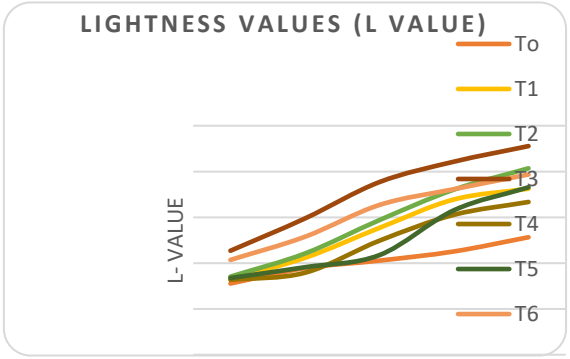


Figure 4:Peroxide value of chicken nuggets (milli equivalents of active oxygen/kg) as affected by addition of different levels of honey at 40C for 28 days of storage Color.

Results in Fig.5 Revealed that Honey imparted a dark tint to the chicken meat, which was maintained over 28 days of storage. However, during 28 days of storage, all treatments included control increased in L*value by 3 to 4 units. Visually, controls appeared paler in color as compared with the honey added samples. At day 0 maximum L value of chicken nuggets was recorded in T3 (68.54±2.98) while minimum mean was evaluated in T0 (67.11±3.45). Furthermore L value was recorded maximum mean after 28 days of storage for T3 (73.11±2.98) and while mean minimum for T0 (69.13±2.36). Moreover the L value increased in all treatments with passage of time during storage. Results in Fig. (5) Showed that L*value for samples incorporated with Citrus Honey were more than samples incorporated with Acacia Honey. Results of this research project are comparable with the findings of (Grumbles et al., 2008 and Kim et al., 2015).

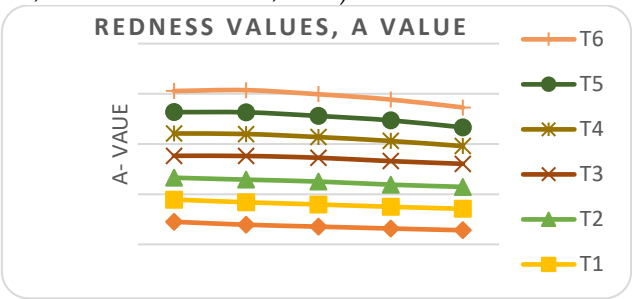


Figure 5:Lightness (L), Redness (a) and Yellowness (b) changes of chicken nuggets affected by addition different levels of honey and stored at 40C for 28 days of storage.

Results in Fig. (5) Showed that increasing honey concentration decreased the samples redness with honey treatments. Moreover, during 28 days of storage the redness decreased in all samples. At day 0 maximum a* value of chicken nuggets was recorded in T0 (4.51±0.02) while minimum was evaluated in T6 (4.21±0.05). Furthermore a value was recorded maximum mean after 28 days of storage for T3 (4.59±0.06) and while mean minimum for T0 (2.82±0.01). These results showed that a value of T0 was highest at fresh level but resulted in lowest with the passage of time to lowest one. Moreover reduction of a value was lowest from fresh to 28 days storage in T1, T2 and T3 means citrus honey treatments. Results in Fig. (5) Showed that a*value for samples incorporated with Citrus Honey were more than samples incorporated with Acacia Hone. Results of this research project are comparable with the findings of (Grumbles et al., 2008 and Barhate et al., 2003).

Fig. 5 showed that increasing honey concentration increase the yellowness in sample containing honey. During 28 days of storage there are no significant changes of b* value was detected in all samples. At day 0 maximum b value of chicken nuggets was recorded in T3 (31.96±2.95) while minimum was evaluated in T0 (30.15±2.21). Furthermore b value was recorded maximum after 28 days of storage for T3 (33.14±4.69) and while mean minimum for T0 (27.87±3.43) (Table 20). These results showed that b value of T3 was highest from at all storages levels from day 0 to 28 while T0 was lowest. Moreover, b value increased in both honey treatments while decreased in control treatment with the passage of time. Results of this research project are comparable with the findings of (Kim et al., 2015; Perlo et al., 2006 and Kumar et al., 2014).

Microbiological analysis of chicken nuggets

Health complications which originate from daily life foods contamination is mainly due to the microbes which are considered to be the most severe issue all around the world. Many of the safety, health and environmental related issues are now becoming major problems because of the use of market available synthetic type and other chemical preservatives in all foods. This use of such additives increasing continuous food poisoning related death rate. Preservative which are derived from plants and animals being natural source are being adopted by

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keeping in mind their safe use. Need of time is to utilized the natural agents for the purpose of safe antimicrobial activity of foods (Zulfa et al., 2016; Cock and Vuuren, 2015).

Table 3: Total Viable Count and total Coliform Count of chicken nuggets affected by addition different levels of honey and stored at 40C for 28 days of storage.

Treatment	Total Viable Count(log10Cfu/g)					Total Coliform Count(log10Cfu/g)				
	0 day	07 day	15days	21 days	28 days	0 day	07 day	15days	21 days	28 days
To	4.85±2.32	6.89±2.45	9.23±3.41	13.71±2.36	18.92±4.12	3.33±0.98	4.75±0.45	6.51±1.21	8.65±1.32	11.93±1.54
T1	4.63±3.12	5.84±2.15	7.31±3.63	9.53±4.10	12.31±2.12	3.13±1.56	4.35±1.65	5.72±1.12	7.82±1.23	9.83±1.45
T2	4.23±2.18	5.34±2.14	6.87±3.12	8.92±3.14	11.62±3.18	3.02±0.87	4.12±0.54	5.31±0.83	7.39±1.24	8.96±1.25
T3	4.32±3.24	5.11±3.27	6.12±4.18	7.97±3.19	10.67±2.18	3.23±0.78	4.08±1.75	4.96±1.98	6.85±1.47	8.17±1.68
T4	4.58±2.17	6.01±2.10	7.63±1.18	10.12±1.13	13.34±0.19	3.34±1.36	4.58±0.83	6.32±1.42	8.56±1.94	10.54±1.41
T5	4.35±0.91	5.98±2.31	7.32±1.81	9.21±2.94	11.97±1.24	3.42±0.87	5.11±1.57	6.32±1.89	8.23±1.74	9.63±1.86
T6	4.54±2.14	5.71±1.04	6.89±1.47	8.45±0.89	11.74±0.34	3.63±0.78	5.57±1.75	6.12±1.98	6.89±1.47	8.72±1.68

Table 3 showed that increasing honey concentration decreased the coliform count moreover; during storage sample with 4g honey had the lowest number of coliform group compared to all other samples. Also all samples with honey had a greater antimicrobial effect than control samples. This results due to honey antibacterial activity against bacteria. At day 0 maximum total coliform count of chicken nuggets was recorded in treatment T6 (3.63±0.78) while minimum was evaluated in treatment T2 (3.02±0.87). Furthermore total coliform count was recorded maximum mean after 28 days of storage for treatmentT0 (11.93±1.54) while minimum for treatment T3 (8.17±1.68). These results showed that total coliform count of control T0increased most among other treatments at all storage levels from day 0 to 28. Moreover both honey treatments found effective against coliform microbial growth while citrus honey showed best antimicrobial activity. Findings of our research are in agreement with the findings of our research work (Szweda, 2017 and Ravi, 2016).

Table (04) showed that increasing honey concentration found effective against mould growth. At day 0 and 7 there was no mold growth detected in all treatments. Furthermore mold count was recorded maximum after 28 days of storage for treatmentT0 (6.32±1.14). These results showed that mold count of control T0increased most among other treatments at all storage levels from day 15 to 28. Moreover both honey treatments found effective against mold growth at above 2g/30g chicken nuggets. Findings of our research are in agreement with the findings of our research work (Mahedran et al., 2015).

Table 4:Mold and yeast Count of chicken nuggets affected by addition different levels of honey and stored at 40C for 28 days of storage.

Table (04) showed that increasing honey concentration found effective against yeast growth. At day 0 and 7 there was no yeast growth detected in all treatments. Furthermore yeast count was recorded maximum after 28 days of storage for treatmentT0 (7.14±0.41). These results showed that yeast count of control T0increased most among other treatments at all storage levels from day 15 to 28. Moreover both honey treatments found effective against yeast growth at treatments (T2, T3, T5 and T6) or above 2g/30g chicken nuggets. Findings of our research are in agreement with the findings of our research work (Szweda, 2017 and Mahedran et al., 2015).

Sensory evaluation of chicken nuggets

Sensory parameters are first choice made by consumer for the acceptance or rejection of food products. Various parameters depending upon the nature of foods are considered in sensory evaluation. For this purpose 9 point

system of sensory evaluation was applied with color, flavor, juiciness, texture, tenderness, sweetness and overall acceptability parameters.

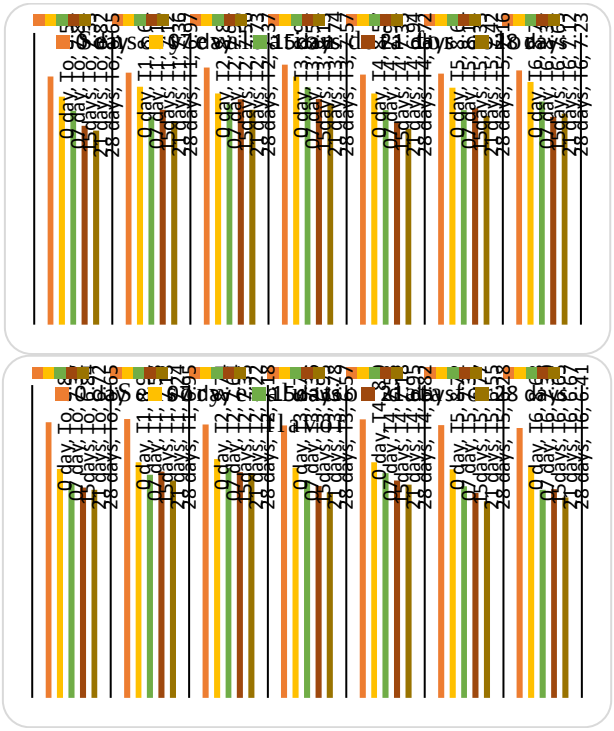
Color acceptance level was recorded maximum mean after 28 days of storage for T3 (7.57±0.26) and while mean minimum for T0 (6.65±0.19) (Figure 06). These results showed that the acceptance of T3 was highest among all other treatments from fresh chicken nuggets to 28 days storage.

Flavor acceptance level was recorded maximum mean after 28 days of storage for T2 (7.18±0.45) and while mean minimum for T6 (6.41±0.27) (Figure 16). These results showed that the flavor acceptance of T1 was highest at fresh stage while T2 was found best at 28 days storage.

Table 4:

Treatment	Mold Count(log10Cfu/g)					Yeast Count(log10Cfu/g)				
	0 day	07 day	15days	21 days	28 days	0 day	07 day	15days	21 days	28 days
To	ND	ND	2.75±0.45	4.34±0.31	6.32±1.14	ND	ND	2.93±0.46	4.76±0.31	7.14±0.41
T1	ND	ND	ND	1.73±0.58	2.31±0.87	ND	ND	ND	1.89±0.43	2.54±0.75
T2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T4	ND	ND	ND	1.92±0.21	3.13±0.14	ND	ND	ND	2.34±0.89	3.79±1.01
T5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
T6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Figure 6: Sensory Characteristics of chicken nuggets affected by addition different levels of honey and stored at 40C for 28 days of storage.



Juiciness hedonic score level was recorded maximum mean after 28 days of storage for T1 (7.72±0.35) and while mean minimum for T6 (6.87±0.46) (Figure 06). These results showed that the juiciness acceptance of T6 was highest at fresh stage while T1 was found best at 28 days storage.

Tenderness level was recorded maximum mean after 28 days of storage for T1 (7.52±0.43) and while mean minimum for T6 (6.54±0.43) (Figure 06).

Texture is the sensory evaluation factors which perceived in mouth and by touch through hands. Granule size, smoothness, softness, hardness and uniformity comes under this category. Texture acceptance level was recorded maximum mean after 28 days of storage for T2 (7.19±0.52) and while mean minimum for T5 (6.27±0.59)

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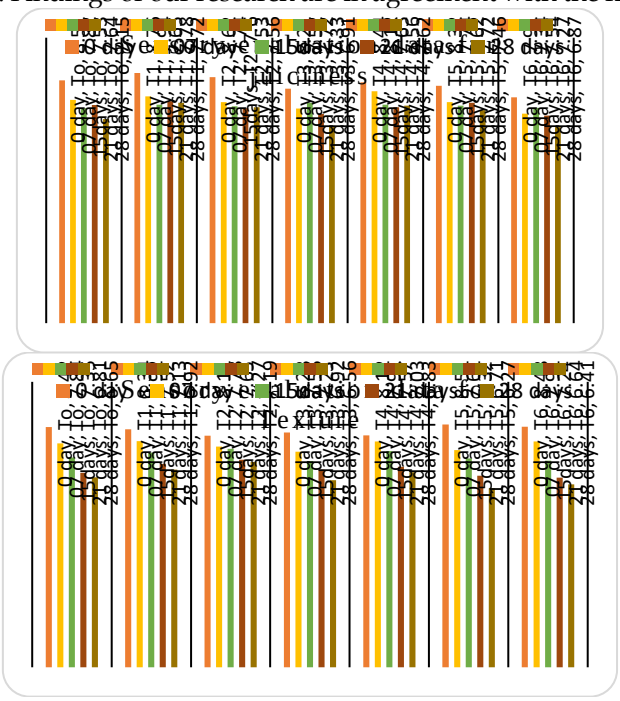
(Figure 06). These results showed that the texture acceptance of T5 was highest at fresh stage while T2 was found best at 28 days storage. Findings of our research are in agreement with the findings of our research work.



These results showed that the tenderness acceptance of T1 was highest at fresh stage and after 28 days storage. Sweetness acceptability level was recorded maximum mean after 28 days of storage for T1 (7.71±0.23) and while mean minimum for T6 (6.34±0.29) (Figure 06). These results showed that the sweetness acceptability of T1 was highest at fresh stage and after 28 days storage. Overall acceptability level was recorded maximum mean after 28 days of storage for T1 (7.93±0.42) and while mean minimum for T6 (7.12±0.35) (Figure 06). These results showed that the overall acceptability of T1 was highest at fresh stage and after 28 days storage.

4. Conclusion

Citrus and acacia honey were found effective in their use for chicken nuggets. In addition to the nutritional value (appreciable amount of carbohydrates, vitamins, minerals, enzymes and antioxidants) of these honey types, the preservative quality also revealed the potential use in chicken nuggets. Whereas in comparison to control and acacia honey treatments, citrus honey was found most effective by increasing sensory as well as quality parameters values. Storage study of chicken nuggets also showed that the application of citrus honey resulted in better quality and microbial control as compared to others.

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