Food Science & Applied Microbiology Reports
Vol. 1(1),2022; 36-48
ISSN (Online) 2958-0684
https://finessepublishing.com/fsamr

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

Amir Shahzad[a], Nida Firdous[b], Husnain Azam[a], Muhammad Sheheryar[a]

a. Government College University, Faisalabad, Pakistan
b. Punjab Food Authority, Pakistan

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 to 30g of 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 days to 28 days. The results showed that both honeys 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 trials 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 a reduction with the increment of both honey quantities, while microbial analysis presented citrus honey (3g/30g chicken nuggets) as 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 has more noticeable results. Keeping in view, the natural product with admirable nutritional and preservative properties can be recommended for use in chicken nuggets, a long-term, valuable, and safe food product.

Keywords: Shelf Life, Sensory, Chicken products

1. Introduction

The 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 an ingredient or preservative. The healing properties of honey and diabetes were the most important factors to use as medicine in the past. Whereas the use in winter as a food provides a healing effect to the body has been practiced for a long time. Use in various foods as a preservative, as well as ingredients such as syrups and other sweet products, due to its physical characteristics that are acceptable in culinary work (Machado De-Melo et al., 2018; Szweda, 2017).

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 used in barbecue 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 higher moisture levels, with favorable conditions of microbial growth as high-risk food (Alnaqdy et al., 2005; Hayman et al., 2004).

Chicken nuggets have gained the status of conventional food in the last few decades because their consumption level increased tremendously from 28 kg in 1991 to 35 kg in 2000 per person per year. Chicken nuggets were

[Received 11 Apr 2022; Accepted 16 June 2022; Published (online) 29 June 2022]

Corresponding email: amir@yahoo.com (Amir Shahzad)
DOI: 10.61363/fsamr.v1i1.16

coated with many food additives and ingredients for various purposes. Recently, the interest in healthy foods has obviously increased the consumption of such low-fat foods (Grunert, 2006).

Honey has positive and valuable nutritional effects on the quality parameters of 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 and 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 is a natural food, is found to be 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 different types of unifloral honey and retard the production of oxidation products related to off-flavor to improve shelf life and flavor.

2. Materials And Methods

2.1. Procurement and storage of raw materials

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

2.2. Preparation of Chicken nuggets

Minced chicken meat emulsion was prepared in the 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. The final product was then presented for the designed treatment 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

2.3. Physicochemical Composition of honey

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

and Klein (2011). Reagents and standards were prepared in HPLC-grade solvents, and the procedure of HPLC working was followed to determine the sugar contents of honey samples.

Brix grade was determined by using an Abbe refractometer using a method that was adopted by James et al. (2009). Diastase, invertase activity, and proline mass fraction were determined using the methods proposed by the International Honey Commission (IHC, 2002).

2.4. 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 equation (Hunter & Harold, 1987). 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).

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

2.5. 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 Bohaychuk et al. (2011) was adopted. The 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 the detection of Staphylococcus spp. The circular, smooth colonies (2-3 mm) were Gram-stained, 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 (Devalakshmi et al., 2010). Yeast and Mold counts were estimated by using agar of potato dextrose, and incubation at 37°C temperature for 35 hours. Colonies were counted manually, and results were expressed as log CFU/g of the given sample.

Sensory characteristics (juiciness, tenderness, odor, sweetness, sweetness acceptability, and flavor acceptability) of chicken meat products were evaluated by 10 trained panelists from the food technology department, National Research Centre. The samples were sliced and placed on a tray in coded containers. The samples were evaluated the next day of production (Antony et al., 2000).

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 tested for significance at ($p<0.05$) using the Duncan test (Paura & Arhipova, 2002).

3. Results And Discussion

3.1. Chemical analysis of honey

Honey is a complex food, and its composition varies depending on the 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, and between fructose and solids, which are parameters well known as proof of botanical origin for honeys. In addition to this, the water activity is a variable parameter rarely defined as discriminated for the different honey types (Barhate et al., 2003; Serrano et al., 2004).

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 the case of glucose, reducing sugars or fructose presence remains in the range of 60g/100g and is further affected by the factors of honey. Carbohydrates, being major ingredients, are major quality determination parameters of honey. The intensity of heating of honey during processing and storage is determined by diastase activity. (Barhate et al., 2003; Karabournioti & Zervalaki, 2001; Tosi et al., 2008).

Mean moisture percentage of citrus honey evaluated in research was 15.79±1.92, while for acacia honey, the mean moisture content recorded was 17.56±0.63 (Table 2). The results of this project are comparable with the findings of (Mohammed et al., 2017; Serrano et al., 2004).

Mean ash of citrus honey evaluated in research was 0.07±0.15while for acacia honey, the mean ash content recorded was 0.23±0.14 (Table 2). These findings are in agreement with the findings of our research work (Uršulin-Trstenjak et al., 2017).

Mean pH of citrus honey evaluated in research was 3.49±0.33, while for acacia honey, the mean pH value recorded was 4.03±0.35 (Table 2). These findings are in agreement with the findings of our research work (Castro-Vázquez et al., 2008; Madas et al., 2014).

Mean glucose percentage of citrus honey evaluated in research was 31.12±5.63, while for acacia honey, the mean glucose percentage recorded was 28.17±1.68 (Table 2). These findings are in agreement with the findings of our research work (El Sohaimy et al., 2015; Marghitas et al., 2010).

Table 2. Chemical analysis data of citrus and acacia honey

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 Mean sucrose percentage of citrus honey evaluated in the research was 1.13±1.49, while for acacia honey, the mean sucrose percentage recorded was 2.34±1.41 (Table 2). These results are in agreement with the findings of our research work (Mohammed et al., 2017).

The Mean fructose percentage of citrus honey evaluated in research was 38.73±2.11, while for acacia honey, the mean fructose percentage recorded was 41.43±1.25 (Table 2). These results are in agreement with the findings of our research work (Mondragón-Cortez et al., 2013; Uršulin-Trstenjak et al., 2017).

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 2). These results are in agreement with the findings of our research work (Castro-Vázquez 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, the mean refractive index recorded was 1.47±0.11 (Table 2). These results are in agreement with the findings of our research work (Madas et al., 2014).

Food Science & Applied Microbiology Reports
Vol. 1(1),2022; 36-48
ISSN (Online) 2958-0684
https://finessepublishing.com/fsamr

The Mean water-insoluble fractions of citrus honey evaluated in research were13.54±18.24 while for acacia honey recorded mean water-insoluble fractions were 13.82±17.14 (Table 02). These findings are in agreement with the findings of our research work (Mondragón-Cortez et al., 2013; Uršulin-Trstenjak et al., 2017).

Mean Proline content of citrus honey evaluated in the research was 203.8±121.53, while for acacia honey, the mean Proline content recorded was 135.81±73.41 (Table 2). These results are in agreement with the findings of our research work (Mohammed et al., 2017).

The Mean diastase activity of citrus honey evaluated in research was 15.75±7.34, while for acacia honey, the mean diastase activity recorded was 15.31±5.12 (Table 2). These results are in agreement with the findings of our research work (El Sohaimy et al., 2015; Marghitas et al., 2010).

The Mean electrical conductivity of citrus honey evaluated in research was 0.45±5.29, while for acacia honey, the mean electrical conductivity recorded was 0.25±5.81 (Table 2). These findings are in agreement with the findings of our research work (Uršulin-Trstenjak et al., 2017).

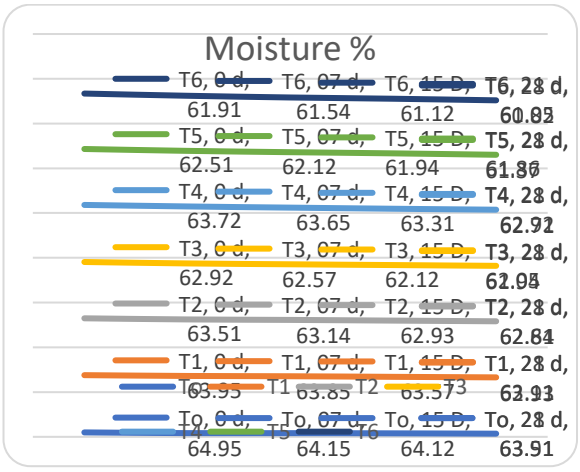
Mean total soluble solids of citrus honey evaluated in the research was 125.7±99.22, while for acacia honey, the mean total soluble solids recorded was 123.3±92.11 (Table 2). These results are in agreement with the findings of our research work (Castro-Vázquez et al., 2008; Madas et al., 2014).

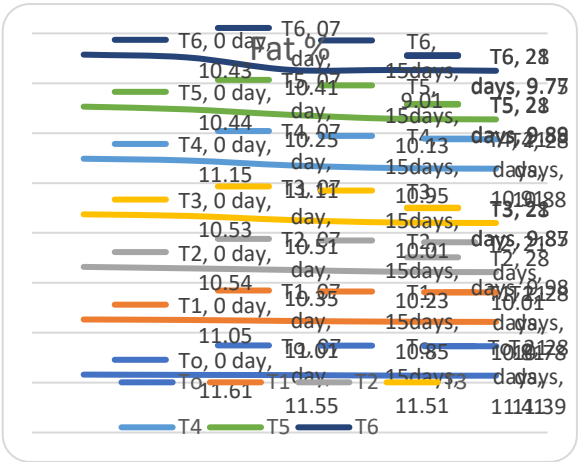
3.2. Chemical analysis of chicken nuggets

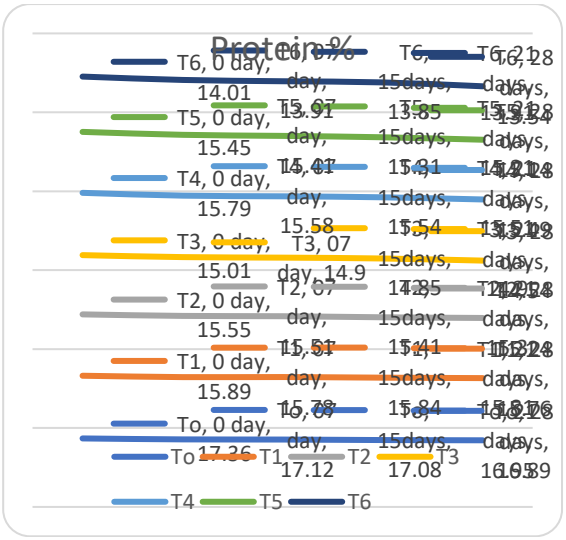
Proximate components of chicken nuggets are primary parameters to check the quality of the products. Moisture, which is the basic component for microbial growth and all other reactions in foods, is a major thing to be considered (Serrano et al., 2004). Fat, protein, and ash are also used to measure here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

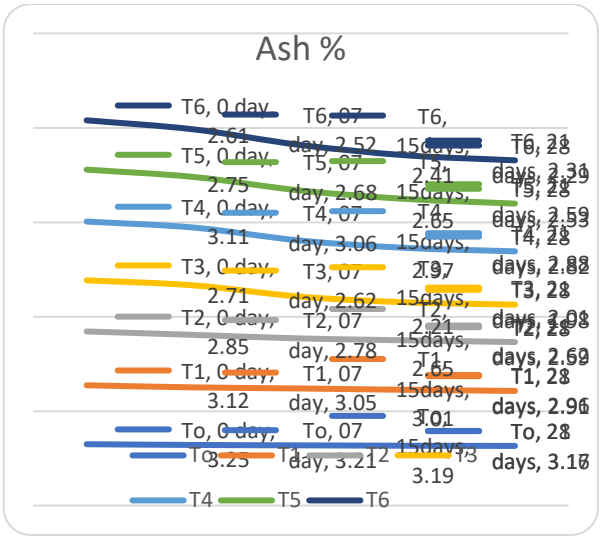
The chemical composition of chicken nuggets as affected by the addition of different levels of honey and stored for 28 days at 40 °C was determined. Data in Fig.1 represent that the control sample (T0) has the highest content of moisture, fat, protein, and ash compared to all samples (64.95, 11.61, 17.36, and 3.25, respectively). By increasing the honey concentration level, the 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 in chemical composition for both honey types. The findings of our research are in agreement with the findings of our research work (Grumbles, 2008; Kim et al., 2015; Kumar et al., 2013; Perlo et al., 2006).

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









3.3. Quality analysis of chicken nuggets

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

3.4. 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. The control sample had the highest values of TBA during storage. At day 0, the maximum value for TBARS of chicken nuggets was recorded in T5 (0.22±0.18) while the minimum mean was evaluated in T6 (0.14±0.17). Furthermore, the TBARS level was recorded as the maximum mean after 28 days of storage for T0 (2.01±0.08), and as the minimum mean for T3(1.13±1.13). These results showed that samples incorporated with Citrus Honey were found to be more effective than samples incorporated with Acacia Honey. Moreover, both Honeys were found effective compared to the control sample during 28 days of storage at 40 °C. These results showed that the citrus honey was found to be effective on TBARS, as increased less than all treatments during storage. The results of this research project are comparable with the findings of (Grumbles, 2008; Kim et al., 2015; Kumar et al., 2013; Perlo et al., 2006).

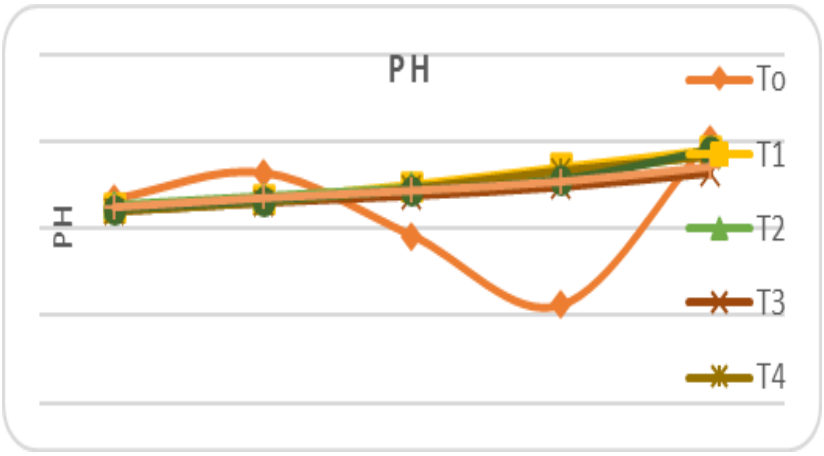


Figure 2: The changes in pH of chicken nuggets as affected by the addition of different levels of honey and stored at 40 °C for 28 days of storage.

Food Science & Applied Microbiology Reports
Vol. 1(1),2022; 36-48
ISSN (Online) 2958-0684
https://finessepublishing.com/fsamr

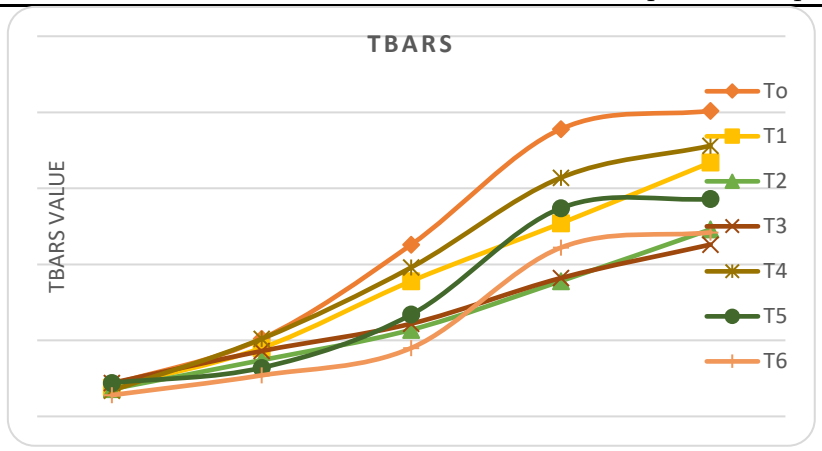


Figure 3: TBA value (mg malonaldahyde/1000g sample) of chicken nuggets as affected by the addition of different levels of honey during 28 days of storage at 40 °C.

3.5. Peroxide Value

Data in Fig. (04) showed that peroxide values of all investigated samples were increased during 28 days of storage. However, the control sample showed the highest peroxide value in seven days of storage, decreases inthe third week. Such a decrease could be due to the transformation of peroxides to malonaldehydes. At day 0, the maximum Peroxide value of chicken nuggets was recorded in T0 (12.23±1.12) while the minimum mean was evaluated in T3 (11.23±1.32). Furthermore, Peroxide value was recorded as the maximum mean after 28 days of storage for T4 (15.47±1.84), and as the minimum mean for T0 (10.12±1.78) (Table 17). These results showed that the Peroxide value of T0 was highest at the fresh stage and after 28 days of storage, while that of T6 was lowest. Moreover, the Peroxide value decreased in all treatments with the passage of time during storage. Peroxide values for samples incorporated with Citrus Honey were less than those for samples incorporated with Acacia Honey. Moreover, both Honeys were found effective against oxidation compared to the control sample during 28 days of storage at 40 °C. The results of this research project are comparable with the findings of (Barhate et al., 2003; Biswas et al., 2006; Kumar et al., 2013; Perlo et al., 2006).

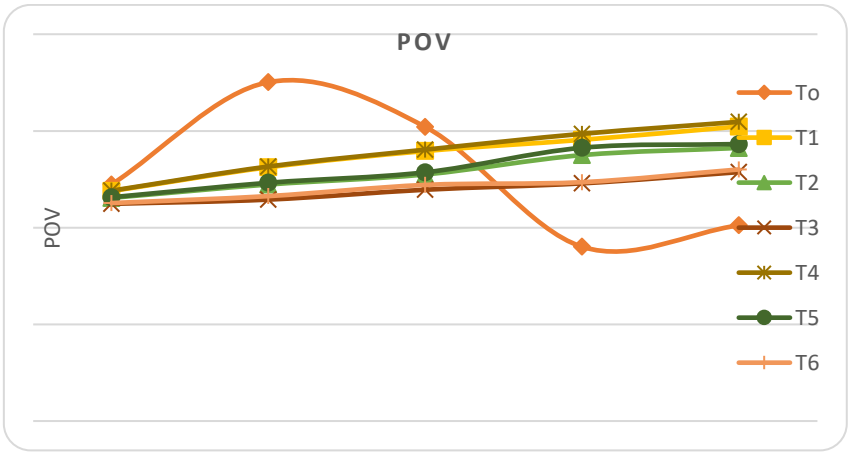


Figure 4: Peroxide value of chicken nuggets (milli equivalents of active oxygen/kg) as affected by the addition of different levels of honey at 40 °C for 28 days of storage

3.6. 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, including the 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, the maximum L value of chicken nuggets was recorded in T3 (68.54±2.98), while the minimum mean was

evaluated in T0 (67.11±3.45). Furthermore, the L value was recorded as the maximum mean after 28 days of storage for T3 (73.11±2.98), and the minimum mean for T0 (69.13±2.36). Moreover, the L value increased in all treatments with the passage of time during storage. Results in Fig.5 showed that the L*value for samples incorporated with Citrus Honey was more than that of samples incorporated with Acacia Honey. Results of this research project are comparable with the findings of (Grumbles, 2008; Kim et al., 2015).

Figure 5: Lightness (L), Redness (a), and Yellowness (b) changes of chicken nuggets affected by the addition of different levels of honey and stored at 40 °C 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, the maximum a* value of chicken nuggets was recorded in T0 (4.51±0.02), while the minimum was evaluated in T6 (4.21±0.05). Furthermore, a value was recorded as the maximum mean after 28 days of storage for T3 (4.59±0.06), and the minimum mean for T0 (2.82±0.01). These results showed that a value of T0 was highest at the fresh level but resulted in the lowest value with the passage of time to lowest one. Moreover, the 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 was more than that of samples incorporated with Acacia Honey. The results of this research project are comparable with the findings of (Barhate et al., 2003; Grumbles, 2008).

Fig.5 showed that increasing honey concentration increases the yellowness in the sample containing honey. During 28 days of storage, there were no significant changes in the b* value detected in all samples. At day 0, the maximum b value of chicken nuggets was recorded in T3 (31.96±2.95), while the minimum was evaluated in T0 (30.15±2.21). Furthermore, the b value was recorded as maximum after 28 days of storage for T3 (33.14±4.69), and as a mean minimum for T0 (27.87±3.43) (Table 20). These results showed that the b value of T3 was highest at all storage levels from day 0 to 28, while T0 was lowest. Moreover, the b value increased in both honey treatments while decreased in the control treatment with the passage of time. The results of this research project are comparable with the findings of (Kim et al., 2015; Kumar et al., 2013; Perlo et al., 2006).

3.7. Microbiological analysis of chicken nuggets

Health complications that originate from daily life foods contamination is mainly due to microbes, which are considered to be the most severe issue all around the world. Many of the safety, health, and environmental-

Food Science & Applied Microbiology Reports
Vol. 1(1),2022; 36-48
ISSN (Online) 2958-0684
https://finessepublishing.com/fsamr

related issues are now becoming major problems because of the use of market-available synthetic types and other chemical preservatives in all foods. The use of such additives increases the continuous food poisoning-related death rate. Preservative which are derived from plants and animals, being natural sources, are being adopted while keeping in mind their safe use. The need of time is to utilize the natural agents for the purpose of safe antimicrobial activity of foods (Cock & Van Vuuren, 2015; Zulfa et al., 2016).

Table 3: Total Viable Count and total Coliform Count of chicken nuggets affected by the addition of different levels of honey and stored at 40 °C 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, the sample with 4g of honey had the lowest number of coliform groups compared to all other samples. Also, all samples with honey had a greater antimicrobial effect than control samples. This results from honey's antibacterial activity against bacteria. At day 0, the maximum total coliform count of chicken nuggets was recorded in treatment T6 (3.63±0.78), while the minimum was evaluated in treatment T2 (3.02±0.87).

Furthermore, total coliform count was recorded as the maximum mean after 28 days of storage for treatment T0 (11.93±1.54) while minimum for treatment T3 (8.17±1.68). These results showed that the total coliform count of control T0 increased the most among other treatments at all storage levels from day 0 to 28. Moreover, both honey treatments were found to be effective against coliform microbial growth, while citrus honey showed the best antimicrobial activity. Findings of our research are in agreement with the findings of our research work (Ravi, 2016; Szweda, 2017).

Table 4 showed that increasing honey concentration was found to be effective against mould growth. At day 0 and 7, there was no mold growth detected in all treatments. Furthermore, mold count was recorded at a maximum after 28 days of storage for treatment T0 (6.32±1.14). These results showed that the mold count of control T0 increased the most among other treatments at all storage levels from day 15 to 28. Moreover, both honey treatments were found to be effective against mold growth at above 2g/30g chicken nuggets. Findings of our research are in agreement with the findings of our research work (Mahendran & Kumarasamy, 2015).

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

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

Table 4 showed that increasing honey concentration was found to be effective against yeast growth. At day 0 and 7, there was no yeast growth detected in all treatments. Furthermore, yeast count was recorded as maximum after 28 days of storage for treatment T0 (7.14±0.41). These results showed that the yeast count of control T0increased most among other treatments at all storage levels from day 15 to 28. Moreover, both honey treatments were found to be 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 (Mahendran & Kumarasamy, 2015; Szweda, 2017).

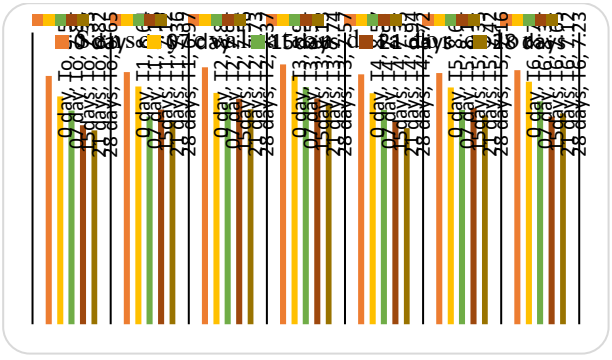
3.8. Sensory evaluation of chicken nuggets

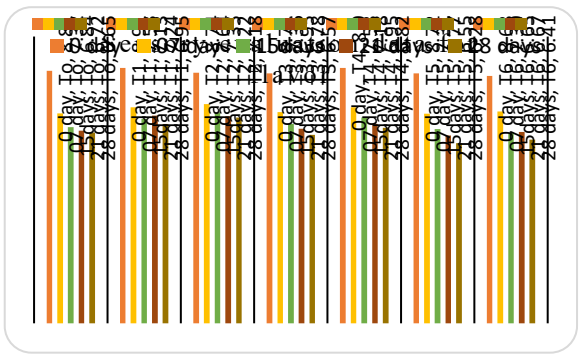
Sensory parameters are the first choice made by consumers for the acceptance or rejection of food products. Various parameters, depending upon the nature of foods, are considered in sensory evaluation. For this purpose, a 9-point system of sensory evaluation was applied with color, flavor, juiciness, texture, tenderness, sweetness, and overall acceptability parameters.

Color acceptance level was recorded as the maximum mean after 28 days of storage for T3 (7.57±0.26) and the minimum mean for T0 (6.65±0.19) (Figure 6). These results showed that the acceptance of T3 was highest among all other treatments from fresh chicken nuggets to 28 days of storage.

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

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



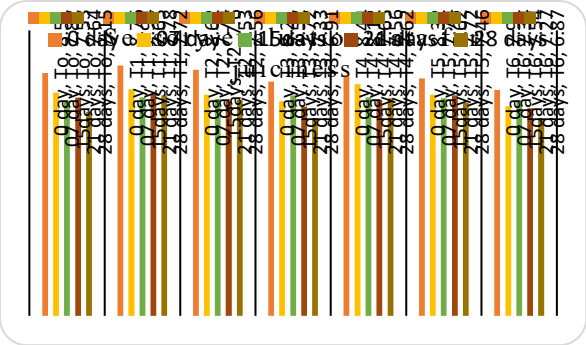


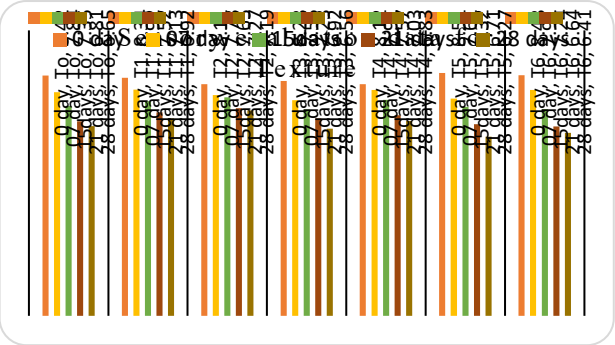
Food Science & Applied Microbiology Reports
Vol. 1(1),2022; 36-48
ISSN (Online) 2958-0684
https://finessepublishing.com/fsamr

Juiciness hedonic score level was recorded as the maximum mean after 28 days of storage for T1 (7.72±0.35), and the minimum mean for T6 (6.87±0.46) (Figure 6). These results showed that the juiciness acceptance of T6 was highest at the fresh stage, while T1 was found to be best at 28 days of storage.

Tenderness level was recorded as the maximum mean after 28 days of storage for T1 (7.52±0.43), and the minimum mean for T6 (6.54±0.43) (Figure 6).

Texture is a sensory evaluation factors which perceived in the mouth and by touch through the hands. Granule size, smoothness, softness, hardness, and uniformity come under this category. Texture acceptance level was recorded as the maximum mean after 28 days of storage for T2 (7.19±0.52) and the minimum mean for T5 (6.27±0.59) (Figure 6). These results showed that the texture acceptance of T5 was highest at the fresh stage, while T2 was found best at 28 days of 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 the fresh stage and after 28 days of storage. Sweetness acceptability level was recorded as the maximum mean after 28 days of storage for T1 (7.71±0.23), and the minimum mean for T6 (6.34±0.29) (Figure 6). These results showed that the sweetness acceptability of T1 was highest at the fresh stage and after 28 days of storage. Overall acceptability level was recorded as the maximum mean after 28 days of storage for T1 (7.93±0.42), and the minimum mean for T6 (7.12±0.35) (Figure 6). These results showed that the overall acceptability of T1 was highest at the fresh stage and after 28 days of storage.

4. Conclusion

Citrus and acacia honey were found to be 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 to be 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.

CRediT authorship contribution statement

Amir Shahzad, Experiment and analyze data, Nida Firdousa, and Husnain Azam, Data analysis, writing original draft, Muhammad Sheheryar, editing, proofreading.

Funding

This work was not financially supported by any funding agency.

Declaration of competing interest

The authors declare no conflict of interest.

Acknowledgments

The author(s) acknowledge that they did not receive any financial support from any funding agency, whether public, private, or non-profit. The study was conducted independently without external funding.

References

Alnaqdy, A., Al-Jabri, A., Al Mahrooqi, Z., Nzeako, B., & Nsanze, H. (2005). Inhibition effect of honey on the adherence of Salmonella to intestinal epithelial cells in vitro. *International journal of food microbiology*, *103*(3), 347-351.

Antony, S., Han, I., Rieck, J., & Dawson, P. (2000). Antioxidative effect of Maillard reaction products formed from honey at different reaction times. *Journal of agricultural and food chemistry*, *48*(9), 3985-3989.

Barhate, R., Subramanian, R., Nandini, K., & Hebbar, H. U. (2003). Processing of honey using polymeric microfiltration and ultrafiltration membranes. *Journal of Food Engineering*, *60*(1), 49-54.

Biswas, S., Chakraborty, A., & Sarkar, S. (2006). Comparison among the qualities of patties prepared from chicken broiler, spent hen and duck meats. *The Journal of Poultry Science*, *43*(2), 180-186.

Bohaychuk, V. M., Gensler, G. E., & Barrios, P. R. (2011). Microbiological baseline study of beef and pork carcasses from provincially inspected abattoirs in Alberta, Canada. *The Canadian veterinary journal*, *52*(10), 1095.

Capita, R., Alonso-Calleja, C., Garcia-Fernandez, M., & Moreno, B. (2002). Characterization of Staphylococcus aureus isolated from poultry meat in Spain. *Poultry Science*, *81*(3), 414-421.

Castro-Vázquez, L., Díaz-Maroto, M., González-Viñas, M., De La Fuente, E., & Pérez-Coello, M. (2008). Influence of storage conditions on chemical composition and sensory properties of citrus honey. *Journal of agricultural and food chemistry*, *56*(6), 1999-2006.

Cock, I., & Van Vuuren, S. (2015). South African food and medicinal plant extracts as potential antimicrobial food agents. *Journal of food science and technology*, *52*(11), 6879-6899.

Collee, J. G., Miles, R., & Watt, B. (1996). Tests for the identification of bacteria. *Mackie and McCartney practical medical microbiology*, *14*, 131-149.

Devalakshmi, N., Reddy, K. P., & Mallika, E. N. (2010). Physico-chemical, sensory and microbial quality of chicken meat chips. *Veterinary World*, *3*(4), 182-184.

El Sohaimy, S. A., Masry, S., & Shehata, M. (2015). Physicochemical characteristics of honey from different origins. *Annals of Agricultural Sciences*, *60*(2), 279-287.

Grumbles, S. L. (2008). *Optimization of ingredient and process parameters for chicken nuggets*. Oklahoma State University.

Grunert, K. G. (2006). Future trends and consumer lifestyles with regard to meat consumption. *Meat science*, *74*(1), 149-160.

Hayman, M. M., Baxter, I., O'riordan, P. J., & Stewart, C. M. (2004). Effects of high-pressure processing on the safety, quality, and shelf life of ready-to-eat meats. *Journal of Food Protection*, *67*(8), 1709-1718.

Hunter, R. S., & Harold, R. W. (1987). *The measurement of appearance*. John wiley & sons.

James, O., Mesubi, M., Usman, L., Yeye, S., Ajanaku, K., Ogunniran, K., Ajani, O. O., & Siyanbola, T. (2009). Physical characterisation of some honey samples from North-Central Nigeria. *International Journal of Physical Sciences*, *4*(9), 464-470.

Kamal, M. A., & Klein, P. (2011). Determination of sugars in honey by liquid chromatography. *Saudi Journal of Biological Sciences*, *18*(1), 17-21.

Karabournioti, S., & Zervalaki, P. (2001). The effect of heating on honey HMF and invertase. *Apiacta*, *36*(4), 177-181.

Kim, H.-Y., Kim, K.-J., Lee, J.-W., Kim, G.-W., Choe, J.-H., Kim, H.-W., Yoon, Y., & Kim, C.-J. (2015). Quality evaluation of chicken nugget formulated with various contents of chicken skin and wheat fiber mixture. *Korean journal for food science of animal resources*, *35*(1), 19.

Kinati, C., Tolemariam, T., & Debele, K. (2011). Quality evaluation of honey produced in Gomma Woreda of South Western Ethiopia. *Livestock research for rural development*, *23*(9), 06-14.

Kumar, V., Biswas, A. K., Sahoo, J., Chatli, M. K., & Sivakumar, S. (2013). Quality and storability of chicken nuggets formulated with green banana and soybean hulls flours. *Journal of food science and technology*, *50*(6), 1058-1068.

Machado De-Melo, A. A., Almeida-Muradian, L. B. d., Sancho, M. T., & Pascual-Maté, A. (2018). Composition and properties of Apis mellifera honey: A review. *Journal of apicultural research*, *57*(1), 5-37.

Madas, M.-N., Francis, F., Marghitas, L., Haubruge, E., Fauconnier, M.-L., & Nguyen, B. K. (2014). Physico-chemical properties and aroma profile of acacia honey produced in Romania. *Communications in agricultural and applied biological sciences*, *79*(1).

Mahendran, S., & Kumarasamy, D. (2015). Antimicrobial activity of some honey samples against pathogenic bacteria. *International Letters of Natural Sciences*, *7*.

Marghitas, L. A., Dezmirean, D. S., Pocol, C. B., Ilea, M., Bobis, O., & Gergen, I. (2010). The development of a biochemical profile of acacia honey by identifying biochemical determinants of its quality. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, *38*(2), 84-90.

Mohammed, M. E. A., Abdallah Alfifi, A. A., Abdalaziz Aalmudawi, A. A., Alfaifi, M. Y., Elbehairi, S. E. I., & Al-Bushnaq, H. A. (2017). Some physiochemical properties of Acacia honey from different altitudes of the Asir Region in Southern Saudi Arabia.

Mondragón-Cortez, P., Ulloa, J., Rosas-Ulloa, P., Rodríguez-Rodríguez, R., & Resendiz Vázquez, J. (2013). Physicochemical characterization of honey from the West region of México. *CyTA-Journal of Food*, *11*(1), 7-13.

Paura, L., & Arhipova, I. (2002). Neparametriskās metodes SPSS datorprogramma: mācību līdzeklis. *Jelgava: LLKC*.

Perlo, F., Bonato, P., Teira, G., Fabre, R., & Kueider, S. (2006). Physicochemical and sensory properties of chicken nuggets with washed mechanically deboned chicken meat: Research note. *Meat science*, *72*(4), 785-788.

Ravi, N. R. (2016). *Effect of honey as natural preservative on total aerobic plate count (APC) of fresh ground chicken meat stored under refrigerator conditon* Faculty of Agro-Based Industry].

Serrano, A., Cofrades, S., & Colmenero, F. J. (2004). Transglutaminase as binding agent in fresh restructured beef steak with added walnuts. *Food chemistry*, *85*(3), 423-429.

Szweda, P. (2017). Antimicrobial activity of honey. *Honey analysis*, *1*, 215-232.

Tarladgis, B. G., Watts, B. M., Younathan, M. T., & Dugan Jr, L. (1960). A distillation method for the quantitative determination of malonaldehyde in rancid foods. *Journal of the American Oil Chemists Society*, *37*(1), 44-48.

Tosi, E., Martinet, R., Ortega, M., Lucero, H. a., & Ré, E. (2008). Honey diastase activity modified by heating. *Food chemistry*, *106*(3), 883-887.

Uršulin-Trstenjak, N., Levanić, D., Grabar, I., Koldenjak, M., & Bošnir, J. (2017). Physico-chemical profiles of Croatian honey with an overview of its consumption among healthcare students. *Journal of applied health sciences*, *3*(1), 51-59.

Zulfa, Z., Chia, C., & Rukayadi, Y. (2016). In vitro antimicrobial activity of Cymbopogon citratus (lemongrass) extracts against selected foodborne pathogens. *International Food Research Journal*, *23*(3), 1262.