Enhanced Knowledge in Sciences and Technology Vol. 1 No. 2 (2021) 193-200

EKST

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/ekst
e-ISSN : 2773-6385

Stability Evaluation Of Chicken Nuggets Formulated With Fibres

Nuramalia Izzati Mohd Rahim[1], Faridah Kormin[1*], Nurul Akhma Zainol Abidin[1], Nurul Alyani Zainol Abidin[1]

[1]Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia, Pagoh Education Hub, 84600 Pagoh, Johor, MALAYSIA

[*]Corresponding Author Designation

DOI: https://doi.org/10.30880/ekst.2021.01.02.023
Received 17 June 2021; Accepted 11 July 2021; Available online 29 July 2021

Abstract: The plant dietary fibre that included bamboo shoot powder (BSP), coconut powder (CP) and modified tapioca starch were used in the chicken nuggets to act as fat replacer. The formulated chicken nugget and the commercial nuggets were studied for their storage stability in term of pH, moisture content, microbiological analysis and sensory quality during storage at (4±1°C). Results shows that the values of pH and moisture content decreased significantly (p<0.05) for each formulation. The total plate count (TPC) were observed and increase significantly during the storage period. The sensory attributes were not significantly changed across time. With the result obtained, it is concluded that nuggets that incorporated with BSP, CP and MTS. Based on the results obtained, it is concluded that nuggets incorporated with fibre exhibited a similar pattern of quality losses during the storage period with the commercial chicken nugget that has preservatives.

Keywords: Storage Stability, Bamboo Shoot Powder, Coconut Powder, Modified Tapioca Starch

1. Introduction

Chicken nugget is one of the fast-food products that have high demand by the consumers. The chicken nugget should have not less than 65% of meat according to Malaysia Food Act 1983 [1]. Fast food products can be categorized as food that has a high content of cholesterols. Therefore, the chicken nugget can also be considered as food that has high cholesterols which is not good to be consumed frequently.

Nowadays, consumers have more knowledge in choosing food products that have a low amount of fat and preservatives in order to maintain good health. Consumers are getting health conscious where they are getting to know that the high consumption of these high cholesterols food will lead to dangerous disease such as heart attack, hypertension, obesity and cancers [2]. The incorporation of phosphate in meat product such as the chicken nugget has been used over these decades to improve the texture and

*Corresponding Email: faridahk@uthm.edu.my

flavour of the chicken nugget [3]. However, the high consumption of phosphate will cause a diverse effect on the body system. Therefore, phosphate has been limited to 0.5 % of phosphate in the final product [4].

In order to overcome the problems of having a high-fat content in chicken nuggets, many studies have been conducted to develop a low-fat chicken nugget. A study by Akesowan [5] shows that fibre which is konjac and shiitake powder which can act as a fat replacer in the chicken nugget when incorporated into the formulation. Fibre is a complex carbohydrate that cannot be digested by the digestive system. It conveys a lot of benefits to the body if it is taken daily. The recommended daily intake of fibre is 28-36 g/day which 70 -80% must be insoluble fibre [6].

In this study, the incorporation of fibres in the chicken nugget to replace the fat and phosphate was conducted by incorporating the bamboo shoot powder, coconut powder and modifies tapioca starch. In this study, two types of fibre are used to be incorporated with the chicken nuggets which are bamboo shoot powder and coconut powder. Bamboo shoots are rich in nutrient components, mainly proteins, carbohydrates, minerals, and fibre and are low in fat and sugars. Besides, they contain phytosterols and a high amount of fibre that can be labelled as nutraceuticals or natural medicines[7]. Coconut (*Cocos nucifera*) is popular in tropical regions, such as in South and Southeast Asia, Africa, Central America and others. A matured coconut endosperm is rich in lipids, proteins and fibres. This type of fibre is the by-product of the manufacturing industry which is very useful for other purposes [8]. The modified tapioca starch has acted as the thickening agent because of its ability to have water holding capacity.[9]

These additions of fibre will help to reduce the fat content in chicken nuggets in comparison with an existing chicken nugget that were high in fat and preservatives. The fibres should improve the storage stability of the chicken nugget compared to the commercial chicken nugget in the market. The fibres in chicken nugget is expected to improve the quality of the nugget as it has a high water-holding capacity which will affect the texture of the chicken nugget. The nuggets flavour may also be affected by the use of fibres especially for the bamboo shoots that has a strong flavour which will be affecting the consumer acceptance of the food. This research is to determine the storage stability of different percentage of the three types of fibres incorporated into the chicken nuggets.

2. Materials and Methods

2.1 Materials

Bamboo shoots powder (BSP), coconut powder (CP) and modified tapioca starch (MTS) was obtained from the Indonesian Institute of Science (LIPI). The sodium tripolyphosphate (STPP), chicken meat, salt, water, black pepper, chicken flavour, onion powder and garlic powder were purchased from a local market.

2.2 Methods

2.2.1 Preparation of Chicken nugget

The production of the chicken nugget is according to Akesowan [5]. Firstly, chicken meat and fat were minced together using a food processor. A brine solution was thoroughly mixed with the minced chicken meat and fat for 30 s using a food processor. Other ingredients such as BSP, CP, MTS, chicken flavour, black pepper, sodium tripolyphosphate, onion powder and garlic powder were added and mixed homogeneously (about 1 min). Each 20 g nugget (4 x 2 x 1 cm^3) was manually formed and kept in a refrigerator at 4℃ for 1 h. After the chicken nuggets were chilled, they were fried by deep fat frying (180 ℃) in palm oil for 3 min (internal temperature about 80 ± 2 ℃). The addition of fibre was added to replace the fat and phosphate which are Formulation 1 has 12.85% of coconut powder, Formulation 2 has 12.85% of modified tapioca starch and Formulation 3 has 1.63% of bamboo shoot powder, 7.74% of coconut powder and 3.48% of modified tapioca starch.

2.2.2 Storage stability

Commercial and formulated nuggets were packed in polyethene bags, sealed and then was kept at kept at (4 ± 2℃) for 0,7,14 and 21 days. The products were analyzed at a studied interval of 7 days. The parameters that were analyzed at the time interval of storage are pH, moisture content, microbiological analysis and sensory acceptability.

2.2.3 pH

The pH of both commercial and the formulated nugget was tested using a digital pH meter (pH700, Eutech Instruments, UK). The pH meter was standardized using pH 4.0, 7.0 and 10.0 before used. 10 g of chicken nugget samples were blended with distilled water (50 ml) to get a uniform suspension. Then all analyzes were performed in three replications for each time interval.

2.2.4 Moisture content

The moisture content in each type of chicken nuggets formulations was determined by using a rapid moisture analyzer (MX50, A&D Company, Japan) according to the method by Akesowan [5] with minor modification. 2.0 g of sample was weighed and then heated at 200℃. The moisture content of the samples is expressed in percentage (%) and the readings were done in triplicate at room temperature of 25℃.

2.2.5 Microbiological analysis

The microbiological analysis of the formulated chicken nuggets was evaluated for bacteria on a plate count agar (PCA). The plate count agar (HIMEDIA, M091, India) was prepared by weighing 23.5 g of PCA powder and dissolved in 1000 ml of distilled water. The mixture was shaken to thoroughly mix the powder and distilled water and it was autoclaved (HICLAVE HV-85, Hirayama, Japan) at 121℃ for 15 minutes before dispensing into Petri dishes. The peptone water was prepared using 1 g of peptone powder in 1000 mL of water (0.1%) and autoclaved to ensure sterilization. Dilution method was conducted every 7 days to determine the presence of bacteria in the nugget. Approximately 1 g of each type of sample nuggets were homogenized in 9 ml of distilled water, followed by serial dilution up to a final dilution of 10^{-3}. 0.1 mL of each diluted sample was pipetted onto a petri dish and the sample was spread in duplicates carefully with a sterilized L spreader. Then, the Petri dishes were incubated (Memmert UNE400, Germany) at (35±2)℃ for 1-2 days. This step was repeated for day zero, 7, 14 and 21.

2.2.6 Sensory analysis

Samples were evaluated by an eight-member experienced panel of judges (Food Technology students from Universiti Tun Hussein Onn Malaysia). A Quantitative Descriptive Analysis was carried out for the attributes of colour, flavour, juiciness, tenderness and overall acceptability using a 9-point hedonic scale, where 9 = extremely like and 1 = extremely dislike. Rectangular pieces approximately 4×2×1 cm^3 were cut and served to the panel members. Water at room temperature was provided to cleanse the palate between samples.

2.3 Statistical analysis

Each determination and measurement results were conducted in three replications unless otherwise indicated. The results were expressed as mean values and standard deviation (SD). The statistical significance was based on a confidence level of 95%. Hence, ($p < 0.05$) indicates that the model terms are significant on the response.

3. Result and discussion

3.1 pH

Table 1 shows that there were changes in the pH value of the chicken nuggets for all of the throughout the storage period. The pH value of the formulated chicken nuggets was lower than the commercial chicken nugget. Therefore, it can be said that the addition of fibres such as BSP, CP and MTS will lower the pH of the chicken nugget. The phosphate also causes the high pH of the chicken nugget. The addition of the STPP in the chicken nugget cause a higher pH that results in the repulsion of meat protein [10].

Table 1: pH measurement of commercial and optimized formulated chicken nugget for 21 days

Days	pH			
	Commercial	F1	F2	F3
0	6.37±0.01	6.13±0.01	5.88±0.00	6.16±0.02
7	6.36±0.01	6.04±0.01	5.87±0.00[c]	6.13±0.01
14	6.11±0.00	6.02±0.01	5.85±0.02	6.07±0.02
21	6.08±0.02	5.93±0.01	5.70±0.00	5.93±0.01

During storage at day 0 to day 7, there was a slight decrease in pH value for all of the formulations. However, the commercial chicken nugget starts to decrease in pH rapidly from day 7 to day 14 compared to the other formulated chicken nuggets. At storage of 21 days, there was a significant decrease in the pH value for Formulation 1, Formulation 2 and Formulation 3. The declining value of pH in the cool storage might be because of the microbial growth in the chicken nugget. The addition of fibres into the chicken nugget help to lower the pH value which helps to inhibit the growth of bacteria by making the environment not desirable for the bacteria to grow.[11].

3.2 Moisture content

The changes in the moisture content are significantly decreased through the storage period. The declining moisture in the chicken nugget might because of the penetration of air into the bags during storage. This caused the moisture content to increase because of the evaporation of moisture from the food during storage. From the data obtained, it can be analysed that the moisture content is the highest in the commercial chicken nugget followed by F2 which incorporated with MTS, then F3 that contained all the three fibres and the least moisture content belong to the F1 which was incorporated with CP.

The commercial chicken nugget has the highest moisture content because of the higher percentage of fat in the nugget. The phosphate in the commercial chicken nugget also helps to retain the moisture in the chicken nugget [12]. This caused the commercial chicken nugget to has a greater percentage of moisture content. However, the formulated chicken nugget with fibres has a lower moisture content which is because of the fibre added to the formulation that lowered the moisture content of the nugget.

The moisture content of the chicken nuggets declined throughout the period time of storage. The commercial chicken nugget has a moisture content that does not significantly decrease compared to the formulated chicken nugget. This may be due to the use of phosphate which helps to retain the moisture in the chicken nugget. However, the other formulated chicken nugget has decreased significantly during storage.

Table 2: The moisture content of the commercial and formulated chicken nugget

Days	Moisture content			
	Commercial	F1	F2	F3
0	66.92±0.44	55.36±0.65	62.12±1.30	61.22±0.28
7	65.39±0.48	53.57±0.83	58.24±0.70	59.15±0.72
14	64.14±0.47	49.16±0.41	58.12±0.93	58.07±0.19
21	61.10±0.33	49.02±0.16	56.28±1.23	55.97±0.90

Formulation 1 has the lowest moisture content during the period of storage. The chicken nugget should be high in moisture retention because the fibre should be able to hold moisture in the chicken nugget based on the study by Mahendran and Sujirtha [13] which state that higher moisture content is due to high fibre content and protein in the coconut flour. Nevertheless, the loss of moisture during the storage may due to the temperature of the refrigerator that leads to the evaporation of moisture in the chicken nugget.

3.3 Microbiological analysis

There was a significant ($p \leq 0.05$) increase in TPC. Table 4 represents the total plate count (cfu/g) in the chicken nugget formulation sample. In the study, it is observed that there were no bacteria formed on day 0 and day 7 for the commercial chicken nugget.

Table 3: Total Plate Count (cfu/g)

Formulations	Total plate count (cfu/g)			
	Day 0	Day 7	Day 14	Day 21
Commercial	0	0	1.0×10^4	1.25×10^4
F1	0	3.35×10^5	3.6×10^5	3.95×10^5
F2	0	4.25×10^4	5.25×10^4	8.25×10^4
F3	0	3.85×10^5	4.025×10^5	4.425×10^5

All the formulation do not have bacteria on day 0. However, each sample of nugget that was incorporated with fibre has bacteria formed on day 7. The cfu/g was analyzed and the TPC increased for all samples until day 21. At the end of the storage, the commercial samples were found to be lowest in TPC while the other samples are still having bacteria count below the permissible limit. This result may due to the phosphate in the chicken nugget that helps to preserve the food. The formulated chicken nugget that has the lowest TPC is the F1 which the nugget was incorporated with 12.85% of MTS. This shows that the MTS has antimicrobial properties that are higher than the other two fibres. According to Malaysia Food Act 1983, meat products should have less than 10^6 cfu/g of total plate count. When the meat products or the chicken nugget exceeds the maximum level of limit, it indicates that the chicken nugget is not safe for consumption because the bacteria in the chicken nugget can produce a toxin that will give an effect on the body [14]. This shows that the chicken nugget formulation which was added with fibres are safe to be consumed until the 21 days of storage at 4°C.

3.4 Sensory evaluation

From Table 4, it can be stated that the sensory properties of the chicken nugget with different formulation will have a significant difference in terms of colour, flavour, tenderness juiciness and overall acceptability.

Table 4: Sensory evaluation of chicken nugget

Sensory properties	Samples	Storage period (Days)			
		0	7	14	21
Colour	Commercial	3.13±1.67	3.83±1.59	3.24±0.36	3.33±1.77
	F1	2.1±1.63	1.88±1.24	1.7±0.33	1.68±1.42
	F2	3.25±2.77	3.58±0.31	3.43±1.07	3.63±1.78
	F3	8.0±1.22	8.0±0.71	8.2±0.35	8.25±0.83
Flavour	Commercial	6.75±1.92	6.18±1.56	5.9±1.19	4.75±2.38
	F1	5.68±2.03	6.65±1.00	5.03±0.18	6.38±0.65
	F2	3.25±1.48	4.01±0.61	4.8±1.35	4.5±0.5
	F3	6.5±0.87	5.9±0.64	6.08±1.25	6.65±0.86
Tenderness	Commercial	2.17±1.45	2.15±1.47	3.9±0.21	4.63±2.0
	F1	7.25±1.92	6.83±2.10	6.15±0.86	7.1±2.29
	F2	3.5±2.06	3.25±1.46	4.2±1.35	3.33±1.59
	F3	6.63±1.78	5.55±1.49	6.13±1.52	6.68±1.59
Juiciness	Commercial	8.00±0.71	6.95±1.71	6.65±0.78	6.75±1.64
	F1	2.25±0.83	3.38±0.70	2.35±1.07	3.13±1.75
	F2	4.83±1.38	4.00±1.73	5.15±1.40	4.0±1.73
	F3	3.6±1.70	4.43±1.97	4.93±3.56	3.3±1.72
Overall acceptability	Commercial	8.21±0.63	8.00±0.71	8.08±1.28	7.5±1.12
	F1	2.25±1.09	2.23±1.096	3.5±1.06	2.25±1.09
	F2	5.09±1.68	5.1±1.71	5.99±0.65	5.37±0.99
	F3	4.5±0.87	4.5±1.10	4.35±0.93	4.75±1.79

For the colour properties, there is a slight increase which may be caused by the non-enzymatic browning of the chicken nugget. The higher score of the colour indicates that the colour of the chicken nugget is becoming darker throughout the storage period. Formulation 3 has a higher score of colour due to the bamboo shoot powder that exhibits a darker colour. The colour perceived by the panellist shows that only slightly different colour can be detected from the sensory test. This shows that from human perception, the colour of the chicken nugget does not change abruptly during the 21 days.

In terms of the flavour of the chicken nuggets, there is a decrease in the score of flavour for all of the formulations. The decline in the score of the flavour of chicken nugget might be because of the development of oxidative rancidity and microbial deterioration in the chicken nugget. The oxidation causes the development of off flavour in the chicken nugget. The undesirable flavour that develops in the product will destabilize the original flavour of the chicken nugget. The oxidation rancidity that develops during the storage period cause the chicken nugget to lose its flavour [15]. However, during this 21 day of storage, the commercial chicken nugget has declined in the flavour score compared to other formulation that still maintains the flavour. This was caused by the lipid oxidation of the chicken nugget in the commercial chicken nugget due to its high-fat content. For the other formulation, the flavour does not rapidly because of the combination of fibres in the chicken nugget.

The tenderness properties of the chicken nugget also evaluated during the sensory evaluation. From Table 4, the tenderness show increament of score for all of the formulation during the storage period.

This happens due to the loss of moisture during the storage period that makes the chicken nugget to be more firm as increase in the period of storage. For formulation 1 that is incorporated with coconut powder, the texture has the highest score which means it becomes firmer through the storage period. The coconut powder tends to have a low binding capacity which the moisture is less held by the coconut powder in the chicken nugget. Formulation 3 that has the combination of BSP, CP and MTS also showing a high score for tenderness because the texture becomes hard throughout storage times. This is caused by the presence of CP in the chicken nugget that makes it lose moisture. Next, the tenderness of chicken nugget with Formulation 2 that has modified tapioca starch, the tenderness has a medium score that shows that the MTS has a high water holding capacity than other fibres which help to give more soft texture to the chicken nugget [16]. Finally, the commercial chicken nugget has the lowest score for tenderness because it has a high-fat content that contributes moisture to the chicken nugget which gives it a softer texture.

The juiciness of the chicken nugget is a contradiction to the tenderness of the food. The higher the tenderness score, the lower the juiciness score of the chicken nugget. This is due to the high incorporation of fibre cause the juiciness of the chicken nugget to be lower. The commercial chicken nugget has a high juiciness score as it has a higher fat content that provides moisture to the chicken nugget. However, it can be analyzed that the juiciness of all the formulation declined throughout the storage period due to loss of moisture by evaporation.

The overall acceptability of the chicken nugget is influenced by all other sensory properties which are colour, flavour, tenderness and juiciness. The degradation of flavour, tenderness and juiciness affected the overall acceptability of the chicken nugget. In this study, the highest score for overall acceptability was for the commercial chicken nugget. This may be due to the high juiciness and soft texture of the chicken nugget. The fat content also enhanced the flavour of the chicken nugget.

4. Conclusion

In a conclusion, there was a decline in the pH value of the chicken nugget due to the increase of microbial growth. The moisture content of the chicken nugget also decreases for all formulation due to loss of moisture during storage. The total cfu/g for all formulations were below 10^6 which is considered safe for consumption. The sensory evaluation on the descriptive analysis of the chicken nugget, show that there is no significant change during the storage. From the result, formulation 2 that incorporated with modified tapioca starch has better storage stability than other formulated chicken nugget.

Acknowledgement

The authors gratefully acknowledge the Department of Technology and Natural Resources, Faculty of Applied Sciences and Technology, University Tun Hussein Onn Malaysia, Pagoh for providing necessary facilities for the successful completion of this research work.

References

[1] R. Singh, M.K. Chatli, A.K. Biswas, and J. Sahoo, “Quality of omega-3 fatty acids enriched low-fat chicken meat patties incorporated with selected levels of linseed flour/oil and canola flour/oil,” J Food Sci Technol, vol. 51, pp. 353–358, 2011.

[2] A., Reynolds et al., “Carbohydrate quality and human health: a series of systematic reviews and meta-analyses,” The Lancet, vol. 393, pp. 434–445, 2019.

[3] S. Barbut, Poultry products processing: an industry guide. Boca Raton, FL: CRC Press. 2001.

[4] J. Smith, and L. Hong-Shum, Food additives databook. 2nd ed. Hoboken, NJ: John Wiley & Sons. 2011.

[5] A. Akesowan, "Production and storage stability of formulated chicken nuggets using konjac flour and shiitake mushrooms," Journal of Food Science and Technology, vol. 53 no. 10, pp. 3661–3674, 2016.

[6] M. Nitin, et al., "Novel Trends in Development of Dietary Fibre Rich Meat Products—a Critical Review," Journal of Food Science and Technology, vol. 52, no. 2, pp. 633–647, 2013.

[7] U. Mustafa, N. Naeem, S. Masood, and Z. Farooq, Z. "Effect of Bamboo Powder Supplementation on Physicochemical and Organoleptic Characteristics of Fortified Cookies," Food Science and Technology, vol. 4, no. 1, 7–13.

[8] D. Sonia, Y. De Leon, and I. Milagros, Coconut. Processing Fruit: Science and Technology. New York, USA: CRC Press. 2006.

[9] S. Pietrzyk et al., "Influence of Amylose Content and Oxidation Level of Potato Starch on Acetylation, Granule Structure and Radicals Formation" in International Journal of Biological Macromolecules, Vol. 106 pp. 57-67, 2018.

[10] S. Glorieux et al., "Phosphate Reduction in Emulsified Meat Products: Impact of Phosphate Type and Dosage on Quality Characteristics," Food Technology and Biotechnology, vol. 55, no. 3, 2017.

[11] J.C. Forest et al., Principles of meat science. W.H. Freeman and Co. UK, 1975.

[12] O.A. Young, S.X. Zhang, M.M. Farouk and C. Podmore, "Effects of pH adjustment with phosphates on attributes and functionalities of normal and high pH beef," Meat Sci, vol. 70, pp. 133-139, 2005.

[13] N. Sujirtha and T. Mahendran, "Use of defatted coconut flour as a source of protein and dietary fibre in wheat biscuits", Int. J. Innovat. Res. Sci .Eng. Technol, vol. 4 no. 8, pp. 7344-7352. 2015.

[14] A. A. Bhat, A. Kumar, S.A. Sheikh, M.Y. Dar, and Z. ul Haq, Utilisation of mango peel powder as Phyto preservative in the refrigeration storage of chicken cutlets, "International Journal of Livestock Research, vol. 7, no. 1, pp. 90-99, 2017.

[15] S. S. Raeisi, S. M. Ojagh, P. Pourashouri, F. Salaün, and S. Y. Quek, "Shelf-life and quality of chicken nuggets fortified with encapsulated fish oil and garlic essential oil during refrigerated storage" Journal of Food Science and Technology. 2020.

[16] J. N. BeMiller "Physical Modification of Starch," Starch in Food, pp. 223–253 2018.