Research Article

Diversification of Healthy Chicken Nuggets Which Rich in Antioxidants and Dietary Fiber Through the Utilization of Vegetable Broccoli (*Brassica oleracea L.*) and Carrot (*Daucus carota L.*)

Riskayanti Riskayanti[1], Hikmah Hikmah[2*], Muhammad Irfan Said[2], Nahariah Nahariah[2]

[1]Student of Animal Science and Technology Program Study, Faculty of Animal Science, Hasanuddin University, Indonesia; [2]Department of Animal Production, Faculty of Animal Science, Hasanuddin University, Indonesia.

Abstract | Nuggets have a high protein content, but are poor in dietary fiber and antioxidant activity. The lack of vegetables is one of the weaknesses of nugget products. Therefore, diversification of processed chicken nugget products with the addition of vegetables is needed. This research aimed to analyze the effect of cooking treatment and vegetable addition level on antioxidant activity, dietary fiber, pH and cooking loss of chicken nuggets. The research design consisted of two factors, the first factor was vegetable cooking treatment (fresh and steamed) and the second factor was vegetable addition level (0%, 10%, 20% and 30%). Parameters measured were dietary fiber content (%), antioxidant activity (%), IC_{50} (ppm), pH and cooking loss of chicken nuggets. The outcomes showed that dietary fiber content and antioxidant activity were higher ($P<0.01$) in fresh vegetables than in steamed vegetables with 7.84% and 44.49%, respectively. The IC_{50} value was higher ($P<0.05$) in the steamed vegetable treatment (150 ppm) compared to fresh vegetable (143 ppm) so then the pH and cooking loss were not different. Increasing the level of vegetable addition increased the dietary fiber content and antioxidant activity but decreased the IC_{50} value and pH of the nuggets. There was an interaction between cooking treatment and the level of vegetable addition ($P<0.05$) on dietary fiber content and antioxidant activity of nuggets. It was concluded that the use of fresh vegetables at a 30% level outcomeed in higher dietary fiber content and antioxidant activity, while decreasing IC_{50} and pH values.

Keywords | Antioxidant activity, Dietary fibre, Healthy chicken nuggets, $IC_{50,}$ local vegetables.

Received | August 18, 2023; **Accepted** | September 20, 2023; **Published** | January 20, 2024
***Correspondence** | H Hikmah, Department of Animal Production, Faculty of Animal Science, Hasanuddin University, Indonesia; **Email:** hikmah@unhas.ac.id
Citation | Riskayanti R, Hikmah H, Said MI, Nahariah N (2024). Diversification of healthy chicken nuggets which rich in antioxidants and dietary fiber through the utilization of vegetable broccoli (*brassica oleracea l.*) And carrot (*daucus carota l.*). Adv. Anim. Vet. Sci. 12(2): 289-296.
DOI | http://dx.doi.org/10.17582/journal.aavs/2024/12.2.289.296
ISSN (Online) | 2307-8316

Copyright: 2024 by the authors. Licensee ResearchersLinks Ltd, England, UK.
This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

INTRODUCTION

Nuggets have high protein substance, but are destitute in dietary fiber and vitamins. Different wellbeing issues such as colon cancer, corpulence and cardiovascular illness can be caused by low fiber admission. According to (Rahmah, 2018) chicken meat has a complete nutritional content, but excessive consumption of speedy food typr can the risk of degenerative disease.

According to (Wibowo, 2015), sources of fiber and antioxidants can be found in vegetables and fruits which contain *flavonoids, riboflavin, flavones, anthocyanins* and vitamin C. Most of the nuggets sold in the market are made from chicken meat without the addition of vegetables, so they are low in micronutrients. Therefore, the content of dietary fiber and antioxidants (Shah et al., 2014) in broccoli and carrots is recommended to be added in making chicken nuggets.

Broccoli is one of the antioxidant-rich ingredients that can be proposed as an anti-atherogenic agent (Talens et

al., 2022). Broccoli contains carotenoids, flavonoids, vitamins A, C, E, *thiamine, riboflavin, beta-carotene, lutein, glutathione,* and *triterpenoids* which are antioxidants (Vania et al., 2019). According to (E., 2019) broccoli (Emeline et al., 2020) has dietary fiber content of 41.72%.

Carrots contain high *beta-carotene*, which is an antioxidant that inhibits the aging process and maintains health (Khatun et al., 2022). In research (Khatun et al., 2022) 2% carrots with 1% ginger extracts may be recommended for formulation of valueadded chicken nuggets as enriched dietary fiber and natural antioxidant. While in research (Aina et al., 2020) about vitamin C content and antioxidant activity in chicken nuggets with the addition of broccoli and purple cabbage, concluded that the best treatment was the 15% broccoli + 15% purple cabbage formula which had a antioxidant activity 54.96%. According to (Susanti, 2017) carrots, including vegetables that have lots of nutritional content are beneficial for all ages, especially for children. Children at an early age need adequate nutrition for their growth and development. According to (Harling, 2017) carrots (Singh et al., 2018) have a dietary fiber (Zinina et al., 2019) content of 41.29%.

The cooking treatment of vegetables will affect the nutritional content and functional nature of the vegetables contained in carrots and broccoli. According to (Latte et al., 2011) all ways of cooking or food processing can reduce the nutritional content of food. Nutrients can also be washed out by the water used for cooking (Buratti et al., 2020) for example boiling potatoes can cause the migration of vitamins B and C to the boiling water. According to (Ishfaq et al., 2022) all cooking treatments (boiling, steaming or sauteing) can reduce the levels of dietary fibre contained in vegetables. According to (Latte et al., 2011) heating broccoli by steaming at boiling point for 5 minutes has a high nutritional value and *glucosinolate* and *ascorbic* acid that can be maintained compared to boiling and microwave.

Based on the above background, the point of this inquire about is to analyze the impact of cooking and the level of vegetable addition and their interaction on antioxidant activity, dietary fiber, and physical quality of chicken nuggets.

MATERIALS AND METHODS

The materials used were broiler chicken breast meat, carrot vegetables, broccoli vegetables (harvest period of 45 days), and other nugget additives. The materials used were DPPH (2,2- diphenyl-1-picrylhydrazyl) powder, methanol and distilled water. The tools used were Shimazu UV-VIS spectrophotometer, Smart Sensor As218 pH meter, micropipette and waterbath. Chicken meat was obtained from Mitra Usaha Jaya Broiler chicken slaughterhouse, Yusuf Bauti street, Paccinongan, Kec. Somba Opu, Gowa Regency, South Sulawesi. Vegetables were obtained from Halal Fresh Makassar store, Batua Raya street No. 103, Batua, Manggala District, Makassar City, South Sulawesi. This study used a completely randomized design (CRD) with a 2x4 factorial and three three replications. Factor A is the cooking treatment of broccoli and carrots, namely A_1 = Fresh and A_2 = Steamed. In contrast factor B is the level of addition of broccoli and carrots B_1 = 0%, B_2 = 10% (5% broccoli and 5% carrots) B_3 = 20% (10% broccoli and 10% carrots) B_4 = 30% (15% broccoli and 15% carrots). The formula for making nuggets: Chicken meat 200g, Tapioca flour 40 g, Garlic 10 g, Pepper 2 g, Salt 5 g, Flavoring 5 g, Eggs 40 g, Ice cubes 30 g, Breadcrumbs 50g.

Research procedure

Vegetable ingredients, namely carrots and broccoli were prepared. The parts that would not be used were removed, such as the skin on carrots and stems on broccoli; the vegetables were cut and washed, then steamed for 5 minutes at 80°C, then soaked in ice water for 10 minutes, and then ground using a blender as well as for vegetables fresh. The breast part of the chicken was cleaned first and then ground. After the meat was ground and smooth, the flour and spices were evenly mixed, then the batter with broccoli and carrots, according to the level of treatment. Meat that had been thoroughly mixed with vegetables was poured into the mould. After printing, the batter was steamed for 30 minutes. The stages of the process of making vegetable nuggets can be seen in Figure 1.

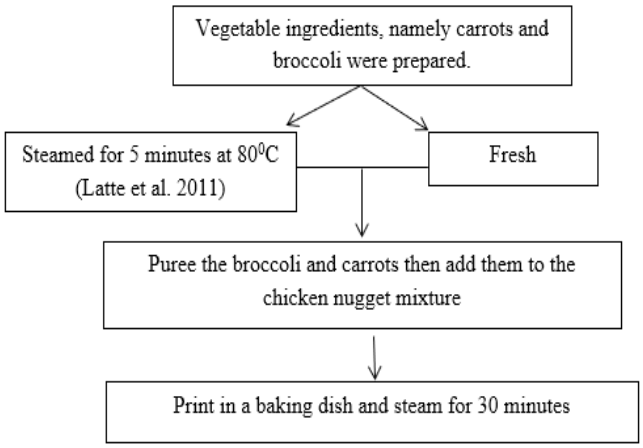

Figure 1: Flow diagram for making nuggets with the addition of broccoli and carrot vegetables.

Parameters

Analysis of food fiber content

The food fiber test method according to AOAC 991.43 by enzymatic gravimetry (18-8-6- 2/MU/SMM- SIG) was conducted at PT Saraswanti Indo Genetech Jl. Rasamala NO. 20, Taman Yasmin, Bogor West Java 16113.

Antioxidant Activity

Antioxidant activity testing was carried out based on (Arham, 2017) that DPPH was weighed at 0.008 g and then dissolved in 50 mL of methanol. Control absorbance was gotten from liquefaction of DPPH with a few concentrations. Liquefaction is done by increase DPPH to 9 mL of methanol. with concentration of 60 ppm, 70 ppm, 80 ppm, 90 ppm and 100 ppm. The absorbance of the arrangement was measured applying a UV-VIS spectrophometer at a wavelength of 515 nm.

A 1 g test sample was liquefacted into 9 mL of methanol and homogenized applying a Vortex. Sample dilution from 104 ppm to 103 ppm. Each dilution of the tested sample added 0.2 mL of sample solution to a test tube and added 3.8 mL of DPPH solution and 0.2 mL methanol. The sample solution mixture was homogenised using a vortex and incubated with 3.8 mL of DPPH solution and 0.2 mL of methanol. 30 minutes in a dark room, then measured using a UV-VIS spectrophometer at a wavelength of 515 nm. The size antioxidant activity is calculated by the formula:

$$DPPH\ Radical\ Scavenging\ Effect\ (\%) = \frac{A\ (DPPH) - A(sampel)}{A\ (DPPH)} X\ 100\%$$

pH

According to (Wala et al., 2016) that 10 g sample was included to 10 mL of distilled water and after that crushed to obtain a homogeneous sample. To measure pH accurately, calibrate the pH meter using pH 4 and 7 buffers first. After calibrating using a buffer, sample measurements will be carried out by dipping the electrode into the solution until a normal value is obtained.

Cooking Loss

A nugget cooking loss test was carried out based on (Arya, 2021) stated that the 10g sample was put in plastic and after that cooked using a water bath at 80°C for 15 minutes. After that the sample is drained and wiped using a tissue to absorb water on the surface of the sample, then the sample is weighed and then calculated. The cooking loss value is calculated using the following formula:

$$Cooking\ loss\ \% = \frac{Weight\ before\ cooking - Weight\ after\ cooking}{Weight\ before\ cooking} x\ 100\%$$

Data analysis

Data processing was carried out by an analysis of variance based on a completely randomized design (CRD) using SPSS Statistics 16.0. Furthermore, if the treatment shows a significant effect (P <0.05), then continued with the LSD (Least Significant Difference) test (Diwangkari et al., 2016).

RESULTS AND DISCUSSION

Dietary fiber

The effect of cooking (fresh and steamed) and the level of adding vegetables to the dietary fiber content of chicken nuggets can be seen in Table 1. it is clear that the outcomes of adding fresh vegetables are superior to those of steamed vegetables with a difference of 3.18%. The outcome of the analysis of variance for the cooking treatment on the food fibre content of the nuggets showed outcomes that had a significant effect (P<0.01), which means that there was an effect of the cooking treatment on the production of chicken nuggets on the food fiber content of the nuggets (Andiana and Ansokawati, 2022). According to (Talukder, 2015) that extrusion cooking in vegetables can dissolve and degrade pectin which causes a decrease in fiber content.

The outcome of the average value of the level of adding vegetables to the highest nugget food fiber content were 30% (7.73%) and the lowest was 0% (3.81%). This shows that the higher the level of addition of vegetables, the higher the dietary fibre content. The outcomes of the analysis of variance for the level of addition of vegetables to the fibre content of the nuggets showed highly significant outcomes (P<0.01). According to the USDA 2019 the dietary fibre content in carrots is 2.8 mg while in broccoli it is 2.6 mg. In the study (Marliyati et al., 2012), stated that the food fiber content of carrot powder was 33.74%. The formulated carrot RTS beverages contained more dietary fiber and ascorbic acid (Poornakala et al., 2020). According to (Ying et al., 2021) Broccoli powder was a wealthy source of protein (30%) and dietary fiber (28%). Carrot powder had less protein (6.5%) and dietary fiber content (24%) and was higher in sugar (47%) compared to broccoli powder (21%). The outcome of the variance analysis of two factors showed that there was an interaction between the cooking treatment and the level of addition of vegetables which had a significant effect (P<0.01) on the fiber sustance of the nuggets. The interaction between these two factors means that the cooking treatment supports each other with the level of addition of vegetables (Figure 2).

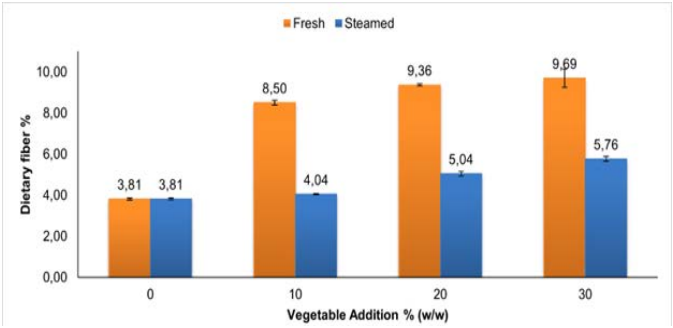

Figure 2: Effect of vegetable cooking and vegetable addition level on dietary fiber content (%) of chicken nuggets.

Table 1: Dietary fiber content, antioxidant activity, $IC_{50,}$ pH and cooking loss of chicken nuggets with different cooking treatments and levels of vegetable addition.

Parameters	Cooking treatment	level of vegetable addition (%)				Average
		0	10	20	30	
Dietary fiber (%)	Fresh	3.81±0.05	8.50±0.12	9.36±0.05	9.69±0.44	7.84±2.48[a]
	Steamed	3.81±0.05	4.04±0.03	5.04±0.12	5.76±0.12	4.66±0.82[b]
	Average	3.81±0.49[a]	6.27±2.44[b]	7.20±2.36[c]	7.73±2.17[d]	
Antioxidant activity (%)	Fresh	25.90±0.51	46.04±0.11	51.97±0.14	54.06±1.04	44.49±11.63[a]
	Steamed	25.90±0.51	45.64±0.14	50.94±0.46	52.09±0.46	43.64±11.00[b]
	Average	25.90±0.46[a]	45.84±0.24[b]	51.45±0.64[c]	53.07±1.29[d]	
IC_{50} (ppm)	Fresh	278±9.73	161±12.34	69.11±1.28	64.71±2.62	143.4±90.98[a]
	Steamed	278±9.73	173±4.05	76.15±0.82	74.03±0.89	150.3±87.75[b]
	Average	278±8.70[a]	167±10.3[b]	72.63±3.97[c]	69.37±5.39[c]	
pH	Fresh	6.23±0.01	6.22±0.01	6.19±0.03	6.17±0.03	6.20±0.03
	Steamed	6.23±0.01	6.21±0.03	6.18±0.04	6.15±0.00	6.19±0.03
	Average	6.23±0.01[a]	6.21±0.02[ab]	6.18±0.03[bc]	6.16±0.02[c]	
Cooking loss	Fresh	10.66±0.40	10.23±0.05	10.26±0.05	10.23±0.05	10.35±0.26
	Steamed	10.70±0.34	10.43±0.40	10.46±0.37	10.26±0.05	10.46±0.32
	Average	10.68±0.33	10.33±0.28	10.36±0.26	10.25±0.05	

Note: Different superscript in the same column show significantly different treatment (P<0.05).

The outcome of the LSD further test (Table 1) showed that the cooking treatment for fresh vegetables was different from that for steamed vegetables. Likewise with the level of adding vegetables where the 30% level is different from 20% and 10% and vice versa. Meanwhile, the 0% control treatment was different from all levels of fresh vegetable addition, while the addition level of steamed vegetable between 0% control did not differ from 10%.

Antioxidant activity

The effect of cooking treatment (fresh and steamed) and level of vegetable addition on the antioxidants activity of chicken nuggets can be seen on Table 1. it is clear that the outcome of adding fresh vegetables are superior to those of steamed vegetables with a difference of 0.85%. The outcome of the analysis of variance for the cooking treatment on the antioxidant activity of the nuggets showed significant outcomes (P<0.01), which means that there was an effect of the cooking treatment on the antioxidant activity of the chicken nuggets in the production of chicken nuggets (Bashir et al., 2022). According to Sari and Ayustaningwarno's (2014) study, fresh broccoli has an antioxidant activity was 78.20% and the antioxidant activity of broccoli pulp decreased to 8.18%. According to (Toydemir et al., 2022) the antioxidant activity in processed vegetables (blanching, canning, sterilizing and freezing) is lower compared to fresh vegetables, this is due to the degradation and absorption of water during boiling which dilutes the compounds and reduces their nutritional content.

The mean value of the level of vegetable addition on the food fibre content of nuggets was the highest at 30% (53.07%) and the lowest at 0% (25.90%). This demonstrates that the antioxidant activity of the nuggets increases with the amount of vegetable added. The increase in antioxidant activity content is due to the antioxidant content of broccoli and carrot vegetables so there is an increase in antioxidant activity in chicken nuggets when compared to the control chicken nugget product (Ribeiro et al., 2019). Broccoli has a great antioxidant capacity because it has an ORAC (*Oxygen Radical Absorbance Capacity*) value or a measure of the food's ability to oxygen-free radicals (Singh et al., 2018), which is classified as superior, which is 890 ORAC units/100 gr (Sisik et al., 2012). The level of vegetable inclusion had a highly significant effect (P<0.01) on the dietary fiber content of the nuggets, according to the variance results. This aligns with the conclusions of (Aina et al., 2020) on chicken nuggets which are added to broccoli and purple cabbage to produce nuggets that have an antioxidant content of 54.96% which is much higher when compared to the control. In the findings of (Das et al., 2020) the addition of 40% carrots to chicken products can increase the content of antioxidant activity up to 45.28%. The outcome of the variance analysis between the two parameters indicated that the amount of vegetable input and the cooking procedure had an interaction that significantly (P<0.01) affected the nuggets' antioxidant activity. The interaction between these two factors means that the cooking treatment supports each other with the level of vegetables addition (Figure 3).

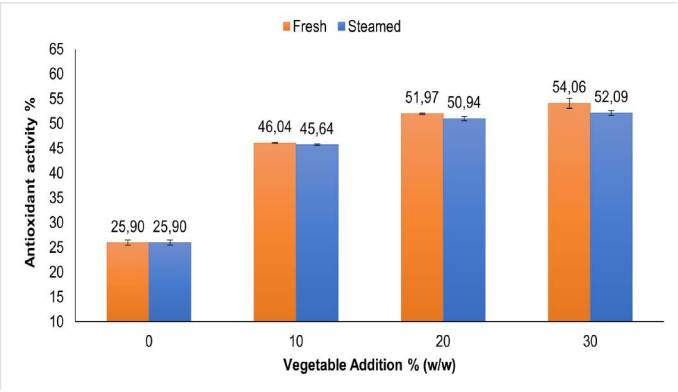

Figure 3: The effect of vegetable cooking and the level of vegetable addition and their interaction on antioxidant content (%) of chicken nuggets.

According to the outcome of the LSD follow-up test (Table 1), there was a variation in the antioxidant activity of the nuggets from the fresh and steamed broccoli and carrot treatments (Villalobos et al., 2018). Similarly, the amount of veggies included indicated a variation in the nuggets' antioxidant activity. Considering Table 1, the level of vegetable addition of 15% is different to that of 10% and 5% and vice versa. Meanwhile, the 0% control treatment was different from all levels of vegetables addition. The difference of antioxidant activity in each treatment was due to the different levels of vegetables addition besides the addition of other ingredients such as garlic and pepper which also had antioxidant activity.

IC_{50}

The effect of cooking (fresh and steamed) and the level of vegetable addition on the IC_{50} value of chicken nuggets can be seen in Table 1. This indicates that chicken nuggets with the addition of vegetables have moderate effectiveness in counteracting free radicals. The outcomes of variance for the treatment of cooking on IC_{50} nuggets show outcomes that have a significant effect ($P < 0.05$), which means that there is an effect of cooking treatment on the manufacture of chicken nuggets on IC_{50} chicken nuggets.

The average value of the level of vegetable addition to the IC_{50} of nuggets, the highest was 30% (69.37 ppm) and the lowest was 0% (278 ppm). This shows that the higher the level of vegetable addition, the higher the of IC_{50} of nuggets will increase, which means that the antioxidant activity of the nugget products will be stronger or more active. The outcomes of variance for the level of vegetable addition to IC_{50} of nuggets showed highly significant outcomes ($P<0.01$). The antioxidant activity of control chicken nuggets was obtained from pepper and garlic. According to (Zargar et al., 2017) the antioxidant activity of garlic is very strong with an IC_{50} value of 10.61 µg/ml. Talukder (2015) reported that the total phenolic and flavonoid methanol extract of pepper was 1.728 mg/g and 1.087 µg/g, respectively.

The level of vegetable addition to the IC50 nuggets and the cooking procedure showed no significant influence, according to the analysis of variance results ($P>0.05$). The cooking method and the amount of vegetable addition do not complement one another when there is no interaction between these two variables.

The outcomes of the LSD follow-up test (Table 1) showed no difference in the treatment of fresh and steamed broccoli and carrots. Meanwhile, the level of vegetable addition showed a difference in the level of 30% different from 10% but not different from 20%. As for the 10% treatment, it is different from 30% and 20%. Then for the 0% control treatment is different from all levels of vegetable addition.

pH

The effect of cooking (fresh and steamed) and the level of vegetable addition on the pH of chicken nuggets can be seen in Table 1. The results of the variance analysis revealed that the cooking method had no discernible impact on the pH of the nuggets ($P>0.05$).

The average amount of vegetable addition to the pH of the nuggets was 30% (6.16), the lowest being 0% (6.23). The outcomes of variance for the level of vegetable expansion to the pH of the nuggets appeared a significant effect ($P <0.05$). This demonstrates that the higher the level of vegetable expansion, the pH of the nuggets will diminish. This decrease in pH may be due to the low pH of finely chopped broccoli and carrot vegetables which are rich in bioactive compounds (Lu et al., 2022). This is similar with the research of (Bhosale et al., 2011) on chicken nuggets consolidated with pounded carrot and pounded sweet potato and the diminish in pH was due to the truth that the pH of the vegetables included to the item was somewhat acidic. According to (Banerjee et al., 2012), broccoli powder extract has pH is slightly lower at 4.90 than the normal pH of meat.

The outcomes of the analysis of variance for the interaction between the cooking treatment and the level of vegetable addition to the pH of the nuggets found that it had no significant effect ($P>0.05$). The absence of interaction between these two factors means that the cooking treatment does not support each other with the level of vegetable addition (Sam et al., 2021). In the mean time, the level of vegetable expansion had a noteworthy impact ($P<0.05$) so that the LSD advance test was carried out in arrange to decide the contrasts in each level of expansion.

The outcomes of the LSD further test (Table 1) on the level of vegetable addition showed a difference in the pH

Links Researchers

of the nuggets from the treatment. Based on Table 1, the 30% level of vegetable addition is different from 10% but not different from 20%. Meanwhile, the 10% addition level is different from 30% but not different from 20% and 0% control.

Cooking Loss

The effect of cooking (fresh and steamed) and level of vegetable addition on the cooking loss of chicken nuggets can be seen in Table 1. The outcomes of variance analysis for cooking treatment on cooking loss of nuggets showed no significant effect (P>0.05). The average value of the level of vegetable addition to the cooking loss of nuggets was the highest at 0% (10.68) and the lowest at 30% (10.25). This appears that the higher the level of vegetable expansion, the lower the cooking misfortune of the nuggets. In the research of (Bhosale et al., 2011), the addition of carrots containing fibre was shown to be able to bind water in sausage products. Reinforced by (Banerjee et al., 2012) that fiber is able to retain water and reduce cooking loss. The outcomes of variance analysis for the level of addition to the cooking loss of nuggets founded no significant effect (P>0.05). The outcomes of the analysis of variance for the interaction between the cooking treatment and the level of vegetable addition to the cooking loss of nuggets found that there is no significant effect (P>0.05). The absence of interaction between these two factors means that the cooking treatment does not support each other with the level of vegetable addition. Therefore, no further test was conducted.

CONCLUSION

Steamed vegetable cooking treatment outcomeed in lower dietary fiber and antioxidant activity, there was no difference in IC_{50}, pH, and cooking loss. Increasing the level of vegetable addition decreased the IC_{50}, pH, and cooking loss of nuggets but increased dietary fiber content and antioxidant activity. The addition of fresh vegetables at 10% had good physical quality, with a dietary fiber value of 6.27%, antioxidant activity of 45.84% and IC50 value of 167 ppm.

ACKNOWLEDGMENTS

This research was supported by the Directorate of Research, Technology and Community Service, Ministry of Education, Culture, Research and Technology (DRTPM 2023).

CONFLICT OF INTEREST

The authrors declare that there is no confict of interest.

NOVELTY STATEMENT

This research has examined the preparation of chicken nuggets mixed with local vegetables. This research can be developed in the future as a fiber-rich and functional processed chicken meat food.

AUTHOR CONTRIBUTIONS

Conceptualization, R.R., H.H., and M.I.S.; investigation, R.R.; analysis and interpretation of data, R.R., H.H., and M.I.S.; original draft preparation, R.R., H.H., and M.I.S.; review and editing, R.R., H.H., and M.I.S.; project administration, N.N.; funding acquisition, N.N. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Aina Q., Layli A.N. Arisandy Y.P. (2020). Vitamin C Content and Antioxidant Activities in Chicken Nuggets with Additions Brokoli and Purple Cabbage', J. Trop. Food Agroindust. Technol., 1(01): 1–10. Available at: https://doi.org/10.21070/jtfat.v1i01.201.

Andiana A.A., Ansokawati A.P. (2022). Analysis of Food Fiber Levels In Chicken Nuggets Added by Morage Leaf Powder', 6(1): 1–5.

Arham (2017). pH Value, Antioxidant Activity and TBA (Thiobarbituric-Acid) Value of Dangke Nuggets with the Addition of Brown Rice Flour and Different Storage Time. Thesis (Unpublished). pp. 274–282.

Arya hangga Prayoga (2021). Physical and Organoleptic Quality of Broiler Chicken Meat Given Rations Made from Local Probiotic Feed). Jambi University Faculty Animal Husbandary. Thesis. 35-40.

Banerjee R., Arun K.V., Arun K.D., Rajkumar V., Shewalkar A.A., Narkhede H.P. (2012). Antioxidant effects of broccoli powder extract in goat meat nuggets', *Meat Sci.*, 91(2): 179–184. Available at: https://doi.org/10.1016/j.meatsci.2012.01.016.

Bashir S. Arshad M. S., Khalid W., Nayik G. A., Al Obaid S., Ansari M. J., Moreno A., Karabagias I. K. (2022). Effect of Antimicrobial and Antioxidant Rich Pomegranate Peel Based Edible Coatings on Quality and Functional Properties of Chicken Nuggets', *Molecules.*, 27(14). Available at: https://doi.org/10.3390/molecules27144500.

Bhosale S.S. Biswas A. K., Sahoo J., Chatli M. K., Sharma D. K., Sikka S. S. (2011). Quality evaluation of functional chicken nuggets incorporated with ground carrot and mashed sweet potato', Food Sci. Technol. Int., 17(3): 233–239. Available at: https://doi.org/10.1177/1082013210382339.

Buratti S., Cappa C., Benedetti S., Giovanelli G. (2020). Influence of cooking conditions on nutritional properties and sensory characteristics interpreted by e-senses: Case-study on selected vegetables. Foods., 9(5). Available at: https://doi.org/10.3390/foods9050607.

Das A.K., Pramod K.N., Pratap M., Subhasish B., Annada D., Wangang Z., Jose M.L. (2020). A comprehensive review on antioxidant dietary fibre enriched meat-based functional foods', Trends Food Sci. Technol., 99(September

2019): 323–336. Available at: https://doi.org/10.1016/j.tifs.2020.03.010.

Diwangkari N., Rahmawati R., Safitri D. (2016). Analysis Of Diversity In Lost Data In A Balanced Grating Design. J. GAUSSIAN, 5(1): 153–162. Available at: http://ejournal-s1.undip.ac.id/index.php/gaussian.

Emilia B. (2019). 'Dietary fibre and phenolic compounds in broccoli (Brassica oleracea Italica group) and kale (Brassica oleracea Sabellica group). A literature study about the potential uses of side streams. Alnarp: Sveriges lantbruksuniversitet'.

Harling H. (2017). 'Exploring the Nutritional Value of Carrots and Determining Attributes that are Favored by Consumers', pp. 8–53. Available at: https://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1457&context=honors.

Ishfaq B., Sameen A., Pasha I., Shahid M., Abrar M. (2022). Evaluation of cookery methods in reduction of pesticide residues and quality attributes of okra fruit (Abelmoschus esculentus L.). Food Sci. Technol. (Brazil)., 42. Available at: https://doi.org/10.1590/fst.86021.

Khatun M. Hossain M.A., Ali M.S., Rahman., Azad M.A.K., Hashem M.A. (2022). Formulation of value added chicken nuggets using carrot and ginger as a source of dietary fiber and natural antioxidant. SAARC J. Agricult., 20(1): 185–196. Available at: https://doi.org/10.3329/sja.v20i1.60611.

Latté K.P., Appel K.E., Lampen A. (2011). Health benefits and possible risks of broccoli - An overview. Food Chem. Toxicol. 3287–3309. Available at: https://doi.org/10.1016/j.fct.2011.08.019.

Lu N., Ma J., Sun D.W. (2022). Enhancing physical and chemical quality attributes of frozen meat and meat products: Mechanisms, techniques and applications. Trends Food Sci. Technol., 124(March): 63–85. Available at: https://doi.org/10.1016/j.tifs.2022.04.004.

Marliyati A., Ahmad S., Mega P.R (2012). Application Of Carrot Powder As A Natural Source Of Β-Carotene In Instant Noodle Products.

Poornakala S.J., Surya N., Shanthi K. (2020). Development of Dietary Fiber Fortified Carrot (Daucus carota sativus) Ready to Serve Beverage. Int. J. Curr. Microbiol. Appl. Sci., 9(10): 3771–3783. Available at: https://doi.org/10.20546/ijcmas.2020.910.434.

Rahmah S. (2018). Addition of Mocaf Flour (Modified Cassava Flour) in Making Vegetable Nuggets. Edufortech, 3(1). Available at: https://doi.org/10.17509/edufortech.v3i1.13541.

Ribeiro J.S., Santos M. J. M. C., Silva L. K. R., Pereira L. C. L., Santos I. A., da Silva Lannes S. C., da Silva M. V. (2019). 'Natural antioxidants used in meat products: A brief review', Meat Science. Elsevier Ltd,. 181–188. Available at: https://doi.org/10.1016/j.meatsci.2018.10.016.

Sam F.E., Teng Z.M., Richard A.A., Rafia S., Bilal A.N., Francis K.A., Shun Y.H. (2021). Physicochemical, oxidative stability and sensory properties of frankfurter-type sausage as influenced by the addition of carrot (Daucus carota) paste. Foods., 10(12). Available at: https://doi.org/10.3390/foods10123032.

Sari K.N., Ayustaningwarno F. (2014). Content Of Fibre, Vitamin C, Antioxidant and Organoleptic Activities Of Brown Brocoli (Brassica oleracea var. italica) CHIPS. J. Nutrit. College. [Preprint]. Available at: https://doi.org/10.14710/jnc.v3i3.6599.

Shah M.A., Bosco S.J.D., Mir S.A. (2014). Plant extracts as natural antioxidants in meat and meat products. Meat Sci. Elsevier BV, pp. 21–33. Available at: https://doi.org/10.1016/j.meatsci.2014.03.020.

Singh B.K., Koley T. K., Maurya A., Singh P. M., Singh B. (2018). Phytochemical and antioxidative potential of orange, red, yellow, rainbow and black coloured tropical carrots (Daucus carota subsp. sativus Schubl. & Martens). Physiol. Molecul. Biol. Plants., 24(5): 899–907. Available at: https://doi.org/10.1007/s12298-018-0574-8.

Sisik S. Guzin K., Murat K, Mukerrem K. (2012). Effects of corn oil and broccoli on instrumental texture and color properties of bologna-type sausage. Int. J. Food Propert., 15(5): 1161–1169. Available at: https://doi.org/10.1080/10942912.2010.517339.

Susanti R. (2017). The Effect of Carrot Addition on Organoleptic Quality and Β-Carotene Levels of Tilapia (Oreochomisniloticus) Nuggets). Scientific Writing. Department of Nutrition. Polytechnic. Available at: https://pustaka.poltekkes-pdg.ac.id/repository/KTI_RIKI_SUSANTI_.pdf.

Talens C. Llorente R., Simó-Boyle L., Odriozola-Serrano I., Tueros I., Ibargüen M. (2022). Hybrid Sausages: Modelling the Effect of Partial Meat Replacement with Broccoli, Upcycled Brewer's Spent Grain and Insect Flours. Foods., 11(21). Available at: https://doi.org/10.3390/foods11213396.

Talukder S. (2015). Effect of Dietary Fiber on Properties and Acceptance of Meat Products: A Review. Crit. Rev. Food Sci. Nutrit., 55(7): 1005–1011. Available at: https://doi.org/10.1080/10408398.2012.682230.

Toydemir G. Gultekin Subasi B., Hall R. D., Beekwilder J., Boyacioglu D., Capanoglu E. (2022) 'Effect of food processing on antioxidants, their bioavailability and potential relevance to human health', Food Chem.: X. Elsevier Ltd. Available at: https://doi.org/10.1016/j.fochx.2022.100334.

Vania D., Basyar E., Soeharti C. (2019). Effect of Broccoli Extract (Brassica Oleracea L. Var Italica) on Aortic Histopathology in Wistar Rats with Hyperlipidemia. Diponegoro Med. J., 8(1): 121–132.

Villalobos-Delgado L.H. L. H., Gutie J. M., Caro I., Ramos M. L., Gonza G. (2018). Natural antioxidants in fresh and processed meat. Sustain. Meat Prod. Process., pp. 207–236. Available at: https://doi.org/10.1016/B978-0-12-814874-7.00011-0.

Wala J. Ransaleleh T., Wahyuni I., Rotinsulu M. (2016). Water Content, pH and Total Microbes Of Chicken Meat Addited White Turmeric (Curcuma mangga Val.). Zootec., 36(2): 405. Available at: https://doi.org/10.35792/zot.36.2.2016.12567.

Wibowo E. (2015) Antioxidant Activity Test of Fresh and Boiled Red Spinach (Alternanthera Amoena Voss.) Using the Dpph (1,1-Diphenyl-2-Picylhydrazyl) Method.) Thesis. Biology Education, Faculty of Tarbiyah and Teacher Training, Walisongo State Islamic University, Semarang. Vol. 151: 10–17.

Ying D., Sanguansri L., Cheng L., Augustin M. A. (2021) 'Nutrient-dense shelf-stable vegetable powders and extruded snacks made from carrots and broccoli', Foods., 10(10). Available at: https://doi.org/10.3390/foods10102298.

Zargar F.A. Kumar S., Bhat Z. F., Kumar P. (2017). Effect of incorporation of carrot on the quality characteristics of chicken sausages. Indian J. Poult. Sci., 52(1): 91. Available at: https://doi.org/10.5958/0974-8180.2017.00019.8.

Zinina O., Merenkova S., Tazeddinova D., Rebezov M., Stuart

M., Okuskhanova E., Yessimbekov Z., Baryshnikova N. (2019). Enrichment of meat products with dietary fibers: A review. Agrono/ Res., 17(4): 1808–1822. Available at: https://doi.org/10.15159/AR.19.163.