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Effectiveness of Broccoli (*Brassica Oleracea Var. Italica*) on Antioxidant Activity and Chemical Quality of Beef Meatballs

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ABSTRACT

The study has purpose for knowing the effect of the addition of broccoli on antioxidant activity, and the chemical quality of beef meatballs. The experimental design used was a completely randomized design (CRD) consisting of 5 treatments and 4 replications. The treatment was meatballs without adding broccoli as a control (T0), adding broccoli with levels of 10% (T1), 12% (T2), 14% (T3) and 16% (T4) of the weight of the meat. The results showed that broccoli increases antioxidant activity because it contains natural antioxidants, increases fiber content because it contains high fiber and reduces fat content because it contains beta carotene. Analysis of variance showed that broccoli content at 16% by weight of meat had a significant effect ($P<0.05$) on antioxidant activity and fiber content. Broccoli content of 10% by weight of meat had a significant effect ($P<0.05$) on fat content. From the results of this study it can be concluded that meatballs with the addition of broccoli with a content of 16% by weight of meat, produce beef meatballs with good antioxidant activity and chemical quality.

Keywords: meatballs; broccoli; antioxidant activity; chemical quality

INTRODUCTION

In Indonesia, meatballs are one of the most popular food products. Meatballs are food products made from processed meat, such as beef, chicken, fish and another livestock meat that are widely known by the public. Meatballs are one of the popular variations of food and are liked by all ages. However, it is also known that as a processed meat product, meatballs have disadvantage. One of the disadvantage of meatball products is high cholesterol and low fiber (Sidik 2013).

Broccoli is a type of vegetable that contains various nutrients such as protein, carbohydrates, minerals and vitamins (USDA 2012). furthermore, broccoli is also a vegetable that is rich in dietary fiber and antioxidants (Handayani and Ayustaningwarno 2014). Broccoli is also known as a vegetable that contains high dietary fiber (USDA 2012). Over the last few decades, people's habits of consuming processed products or instant food have led to a decrease in consumption of dietary fiber (Setyawati and Rimawati 2016). According to Rayahu et al., (2019) dietary fiber can prevent health problems such as obesity, hemorrhoids, constipation, colon cancer, diabetes mellitus, diverticolosis diseases, and coronary heart disease which are associated with high cholesterol levels and blood pressure.

Broccoli is a vegetable that is also rich in antioxidants. Armah et al., (2015) broccoli is one of the vegetables that is rich in antioxidants, especially the sulforaphane group which has many benefits for the body. Butnariu and Butu (2015) broccoli also contains hydrochinoglicosides, quercetin, and indoles, as well as cellulose.

Another benefit of broccoli is its ability to reduce the fat content in processed meat products. Several studies have been conducted to determine the ability of broccoli to reduce the fat content of meat. beef meatballs added to broccoli cause a decrease in fat content. The more broccoli added, the lower the amount of fat contained in the meatballs. Gusnun (2019) research on rabbit meat nuggets also reported that broccoli can reduce the fat content in rabbit nuggets. The same results were also reported in Kumar et al.'s study (2013) on emu meat nuggets and Farag's (2014) study on ostrich meat nuggets.

MATERIALS AND METHODS

Materials and tools

The materials used in the study were beef, broccoli, tapioca flour, ice cubes, garlic powder, ground pepper, and sodium tripolyphosphate. The tools used in this research are knives, cutting boards, scales, meat choppers, meat grinders, pots, basins and stoves. This meatballs start with washed broccoli with salt water, then chopped broccoli into small sizes. Broccoli that has been chopped is weighed and mashed with a blender with the addition of water 1:1. Put the meat, salt, sodium tripolyphosphate and ½ part of the ice cubes, into the meat chopper then stir well for 2 minutes.

After the mixture is well mixed, add the tapioca flour, garlic powder, ground pepper and broccoli to the mixed meat, then mix again for 3 minutes until the mixture is thoroughly mixed. Heat the water until it boils, then turn off the stove.

Then the beef meatball dough that has been rounded to form balls is put into the hot water. Turn on the stove and wait for 7 minutes (until the meatballs float completely). Remove the meatballs and drain.

TABLE 1: Ingredients Composition in Each Treatment.

No	Ingredients	Weight of ingredients (grams)				
		T0	T1	T2	T3	T4
1	Beef	200	200	200	200	200
2	Broccoli	0	20	24	28	32
3	Tapioca Flour	60	60	60	60	60
4	Ice cubes	60	60	60	60	60
5	Garlic powder	6	6	6	6	6
6	Pepper powder	2	2	2	2	2
7	Sodium Tripolyphospat	1	1	1	1	1
8	Salt	4	4	4	4	4

Methods

Analysis of antioxidant activity was conducted by measuring free radicals' inhibition against 1,1-diphenyl, 2-picrylhydrazil (DPPH). Samples were dissolved in methanol with various concentrations. Make a 100 ppm DPPH solution by weighing 0.01 gram of DPPH solid and dissolving it with methanol in a 100 mL Erlenmeyer flask. Measure the maximum DPPH wavelength using a UV-Vis spectrophotometer. Prepare 2 ml of each sample, then add 2 ml of DPPH and homogenize. The solution was left for about 40 minutes. Measure the absorbance of the solution at the maximum wavelength that has been obtained. Measure the wavelength of the blank (DPPH:Methanol 1:1) at the maximum wavelength. Calculate the antioxidant activity of the absorbance obtained

The method for analyzing fiber content is in accordance with the Indonesian National Standard 01-2891-1992 concerning Methods for Testing Food and Beverages. Weigh the dry sample as much as 2-5 grams. Place the sample in the flask or Erlenmeyer. Add 50 ml of 1.25% sulfuric acid. The sample is heated in a liebieg pyrex condenser for 1-2 hours. Filter and wash the sample with hot distilled water. Add 3.25% NaOH to the residue and heat it with a liebieg pyrex condenser for 1-2 hours. Filter the sample using filter paper of known weight and wash with ethanol (to dissolve sugar) and hot distilled water until only the fiber remains on the filter paper or until it is white. Heat the filter paper containing the fiber in the oven at 105 0C for ± 6-8 hours to remove the water content. The filter paper is cooled and weighed. Fiber content is calculated with the following formula

$$\% \textbf{ fiber} = \frac{\mathbf{w_2 - w_1}}{\mathbf{w}} \times \mathbf{100}\%$$

w : sample mass (g)
w_1 : paper mass before treatment (g)
w_2 : paper mass after treatment (g)

Fat analysis based on Indonesian national standards 01-2891-1992 Concerning Methods for Testing Food and Beverages with the Direct Extraction Method with a Soxhlet Tool. Put 1-gram sample in a paper sleeve lined with cotton. Plug the paper sleeve containing the sample with cotton, dry it in an oven at a maximum temperature of 80°C for ± 1 hour, then put it in a soxhlet tool that has been connected to a fat flask containing boiling stones which has been dried and has a known mass. Extract with fat solvent (hexane or petroleum ether) for ± 6 hours. Distill the fat solvent and dry the fat extract in an oven at 105°C. Cool and weigh Repeat weighing until a constant mass is obtained. fat content is calculated with the following formula:

$$\% \textbf{ fat} = \frac{\mathbf{w_2 - w_1}}{\mathbf{w}} \times \mathbf{100}\%$$

w : sample mass (g)
w_1 : fat flask mass before extraction (g)
w_2 : fat flask mass after extraction (g)

This experiment used a completely randomized design with 5 treatments of different levels of broccoli addition (0%, 10%, 12%, 14% and 16%) and four replications. Mean values for various parameters were calculated and compared by analysis of variance using the SPSS software for windows (version 22.0). Means of, antioxidant activity, fiber content and fat content were analyzed using one-way ANOVA. Statistical significance was identified at the 95% confidence level ($P<0.05$). The values were presented as mean along with standard error (Mean±Standard Error). If a significant effect is found, then the analysis is continued with the DUNCAN test

RESULTS AND DISCUSSION

Test results for antioxidant activity and chemical quality of beef meatballs with the addition of broccoli (*Brassica Oleracea var Italica*) with different levels, T0: without the addition of broccoli, T1 with the addition of 10% broccoli, T2 with the addition of 12% broccoli, T3 with the addition of 14% broccoli and T4 with the addition of 16% broccoli shown in the following table:

TABLE 2: Effect of adding broccoli with different levels on antioxidant activity and chemical quality of beef meatballs.

Parameter	Treatment				
	T0	T1	T2	T3	T4
Antioxidant Activity (ppm)	4936^{e} ±10,30	4868,1^{d}±14,16	4803,7^{c}±7,88	4789,7^{b}±5,34	4753,1^{a}±3,51
Fiber content (%)	1,15^{ab}±0,09	1,56^{bc}±0,29	1,14^{b}±0,34	1,06^{a}±0,03	1,64^{c}±0,12
Fat content (%)	0,94^{b}±0,87	0,51^{a}±0,04	0,52^{a}±0,06	0,57^{a}±0,03	0,58^{a}±0,00

*Different superscripts in the same column showed significant differences (P<0.05).

Antioxidant activity

Meatballs with the addition of broccoli were determined for their antioxidant activity based on their ability to scavenge the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical. 2,2-diphenyl-1-picrylhydrazyl is a purple radical compound which when the radical is captured by an antioxidant, the intensity of the purple color decreases when measured using a spectrophotometer at 517 nm. The lower the absorbance value means the higher the antioxidant activity (Wariyah and Riyanto 2018).

The antioxidant activity of a food ingredient can be described through IC50. The IC50 value indicates the concentration level of broccoli that can reduce DPPH activity by 50%. Based on statistical tests, the results showed that the addition of broccoli to beef meatballs had a significant effect on inhibiting DPPH free radical activity (P<0.05), this means that the addition of compounds that have antioxidant properties derived from broccoli causes one free electron in DPPH to bind to an atom H derived from these compounds, so that DPPH will lose its free radical properties. The loss of free radical properties from DPPH causes delocalization of electrons to not occur in the DPPH molecule, so that the purple color of DPPH gradually becomes less intense. The reduced intensity of this color will be proportional to the amount of DPPH free radicals that can be captured by compounds that have antioxidant properties (Nasrudin et al., 2015).

The average IC50 value of this study ranged from 4753.125 - 4936. This means that 50% of DPPH free radicals were successfully inhibited by broccoli extract with a concentration of 4753.125 - 4936 ppm. This value is included in the category of very weak antioxidant properties. Molyneux (2004) classifies antioxidant properties into 5 categories as shown in the table.

TABLE 3: Antioxidant properties based on the results of measuring IC50 values with the DPPH method.

No	IC50	antioxidant properties
1	<50 ppm	Very strong
2	50 ppm-100 ppm	strong
3	100 ppm -150 ppm	moderate
4	150 ppm – 200 ppm	weak
5	>200 ppm	Very weak

The low IC50 value in this study was due to the low antioxidant activity of the extract. Wikanta et al., (2005) several factors that led to very low antioxidant activity test results were the samples tested which were samples that were crude extracts that still contained other compounds such as salts, minerals and other nutrients that could inhibit the action of antioxidant compounds.

Another factor that caused the antioxidant activity test results in this study to be very low was because broccoli as a source of antioxidants in this study had very low antioxidant activity. Rahwati et al., (2017) broccoli extract has very low antioxidant activity with an IC50 value of 4998.1 ppm.

According to Widyawati et al., (2010), differences in antioxidant activity are caused by several factors, namely differences in the ability to transfer hydrogen atoms to free radicals, the chemical structure of antioxidant compounds, and the pH of the reaction mixture. Antioxidant activity can also be affected by the number and position of hydroxyl and methyl groups on the ring. Molecules that have more hydroxyl groups will be stronger in capturing free radicals because of their greater ability to donate hydrogen atoms.

Fiber content

The results of the analysis of variance showed that the ratio of broccoli used in making meatballs had a significant effect (P<0.05) on the fiber content of meatballs. The average results of the analysis of the fiber content of beef meatballs with the addition of broccoli are shown in Table 6. The fiber content in this study ranged from 1.06% -1.64%. The fiber content of meatballs is influenced by the fiber content of the raw materials used. Broccoli is a type of vegetable that contains high fiber (Mukherjee and Mishra 2012). In this study it is known that the addition of broccoli causes an increase in fiber content in beef meatballs.

Fat Content

The results of the analysis of variance showed that the addition of broccoli made a significant difference (P<0.05) to the fat content of the meatballs. The average fat content in the meatballs in this study was 0.94% - 0.51% (Table 2). Where the fat content of meatballs without the addition of broccoli is 0.94% and the lowest fat content of meatballs with the addition of broccoli is 0.51%, this result is in accordance with research conducted by Serdaroglu (2009) on beef meatballs, Gusnun's research (2019) on meat nuggets rabbits, research by Kumar et al., (2013) on emu meat nuggets and Farag's (2014) study on ostrich meat nuggets.

The decrease in fat content in the meatballs added with broccoli was caused by the carotene content in broccoli. According to Sani et al., (2019) broccoli is a vegetable that contains high beta carotene. Raw broccoli contains 10,444.245 µg/100 gram of beta carotene, while boiled broccoli contains 5,856 µg/100 gram of beta carotene.

A decrease in the level of fatty acid content by providing a source of β-carotene was also reported by Randa et al., (2021) where the addition of red fruit extract and kebar fruit extract as a source of antioxidants into the shredded deer meat mixture, was able to reduce the fat content in Floss. This is also in accordance with the results of research by Chumanov et al., (2022) that the addition of carrots to processed mutton products reduces the fat content of meat.

CONCLUSION

Broccoli (Brassica oleracea var. italica) contains phytochemical compounds that act as natural antioxidants. The addition of broccoli to beef meatballs is effective in increasing antioxidant activity, increasing fiber content and reducing fat content. The addition of broccoli with a level of 16% effectively increases the antioxidant activity, fiber content dan decrease fat content of beef meatballs.

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