Asian Journal of Advances in Agricultural Research

Volume 22, Issue 4, Page 12-21, 2023; Article no.AJAAR.101083
ISSN: 2456-8864

Optimization Chicken Meatball Using Red Lentil Flour (*Lens culinaris* L.) as Filler

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAAR/2023/v22i4446

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/101083

Original Research Article

Received: 10/04/2023
Accepted: 12/06/2023
Published: 23/06/2023

ABSTRACT

Aims: The aim of the study was to determine the quality of chicken meatballs added with red lentil flour based on physicochemical quality, organoleptic quality, and microstructure. Sample: chicken meatballs using red lentil flour.
Methodology: Laboratory experiment using Completely Randomized Design (CRD). The data were tabulated using Microsoft Excel, and the standard deviation (SD) was taken, then an Analysis of Variance (ANOVA) was performed. If different, proceed with the DMRT (Duncan's Multiple Range Test). Research at the Laboratory of Animal Product Technology Faculty of Animal Science, the Laboratory of Food Quality and Safety Testing Faculty of Agricultural Product Technology, the Universitas Brawijaya Malang, and the Integrated Research and Testing Laboratory Universitas Gadjah Mada Yogyakarta. February 2023. Research with four treatments consisting of without the addition of red lentil flour and the addition of red lentil flour 3%, 6%, and 9%. 5 replications.

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Results: Chicken meatballs added with red lentil flour fiber are the best chicken meatballs by producing chicken meatballs with fiber content and have a color that is not pale. The best treatment for chicken meatballs has a fat content of 9.18%, ash content of 2.68%, fiber content of 0.84%, pH 6.26, organoleptic (color 3.68) (taste 2.98) (texture 3.43), and microstructures of chicken meatballs have different shapes and dense.
Conclusion: The best chicken meatballs are found by adding 9% red lentil flour (*Lens culinaris* L.) to produce, healthy chicken meatballs that contain fiber and have attractive colors. The best product assessment is based on meatball standards in Indonesia and can be accepted by consumers.

Keywords: Chicken meatballs; red lentil flour; restructured meat; physicochemical; organoleptic quality; microstructure.

1. INTRODUCTION

Restructured meat is a processing method that is generally used for meat. Restructured meat is a low meat processing process, such as the condition of the meat being moist and pale in color, and then processing with spices and flour, which aim to produce new products. Restructured meat method aims to improve product quality, such as the texture of food products. One of the ingredients that can be added to restructured meat products is red lentil flour which contains fiber [1].

Meatballs added with 25% wheat flour produced the best chicken meatballs with texture and overall acceptability, rated the best, and were liked by many panelists [2]. The best treatment for chicken meatballs was added with 3% gelatin with a yield value of 109.06%, and the addition of 3% agar had a water-holding capacity of 29.33 g/g [3]. Beef meatballs coated with 3% pumpkin seed flour (*Cucurbita pepo* L.) produce the best quality beef meatballs with low-fat content [4]. Chicken meatballs plus oyster mushrooms can increase the fiber content of meatballs [5]. Chicken meatballs can be added with vegetables such as spinach or nuts to produce healthier meatballs [6].

Meatballs are food with the essential ingredients of mashed meat added with flour then molded into rounds and then cooked until cooked [7]. Meatballs are currently being developed with the essential ingredients of chicken meat; the resulting chicken meatballs have a good taste and are liked by consumers [8]. Chicken meatballs generally have drawbacks, including pale color, less dense and compact, and less fiber [9].

A filler is a material added to food to improve product quality, such as texture. One of the fillers that can be added to chicken meatballs is red lentil flour. Adding red lentil flour to chicken meatballs can produce healthier chicken meatballs that contain fiber, and chicken meatballs have better quality, such as having a more attractive color. Besides functioning as a filler, red lentil flour also functions as a binder in food products [10]. Red lentil flour comes from legumes which are included in the category of agricultural plants that grow with bush-like leaves [11]. Red lentil flour comes from red lentil seeds, with a flat, round shape. Red lentil seeds have been widely traded in the market with an intact flat round shape or seeds that have been split. Red lentil seeds are then processed into flour, which can be added to food to produce a healthy meal [12].

Red lentil flour has health benefits, such as reducing diabetes, obesity, and cancer [10]. Red lentil flour contains 10% - 20% fiber, 0.7% fat, 35% - 53% starch, and 71.5% carbohydrates [13], 5 – 28 mg/100 g carotenoids which give a red to orange color [14], 27% protein [15], 89% calcium [16]. So adding red lentil flour to chicken meatballs can improve the quality of chicken meatballs and further attract consumer interest in chicken meatball products.

2. MATERIALS AND METHODS

2.1 Materials

Ingredients: broiler chicken breast, red lentil flour (fiber 3.33%, moisture 10.6%, protein 24.48%, fat 0.38%, ash 2.32%, and carbohydrate 59.9%) [17], tapioca flour, salt, sugar, pepper, chicken egg white, fried garlic, fried shallots, and ice cubes. The chemicals used were hexane solvent, acid detergent solution, filter paper, hot water, aquades, 2.5% glutaraldehyde, 0.2M phosphate buffer solution, and ethanol.

Tools: vessel, wooden mat, spoon, chicken meat grinding machine, digital scale, knife,

thermometer, pan, LPG gas, stove, spatula, stopwatch, fat content (cup, soxhlet extractor, oven, scale), ash content (cup, balance, oven, desiccator), fiber content (scales, 600 ml beaker, filter paper, vacuum pump, oven, desiccator), pH (pH meter), organoleptic quality (organoleptic worksheet), and microstructure (scanning electron microscope spectrophotometer).

2.2 Methods

Experiments in the laboratory are the method used in research. The design used is a Completely Randomized Design (CRD). The treatments used were 4, namely without adding red lentil flour as a control and adding 3%, 6%, and 9% red lentil flour, and using five replications. Data were tabulated using Microsoft Excel, and the standard deviation (SD) was taken, then an Analysis of Variance (ANOVA) was performed. If different, proceed with the DMRT or Duncan's Multiple Range Test.

2.3 Procedure for Making Chicken Meatballs

The steps for making chicken meatballs with the addition of red lentil (*Lens culinaris* L.) flour were modified from [18], namely 800 g of chicken meat (4 treatments of 200 g each) cleaned, cut into small pieces measuring 2x2x2 cm^3 and then mashed using a meat grinder. Next, mix the ingredients for ground beef and red lentil flour ingredients 3% (6 g), 6% (12 g), and 9% (18 g). The formula for each group was added 1 g of pepper, 4 g of fried garlic, 4 g of fried shallots, 4 g of chicken egg white, 35 g of tapioca flour, 6 g of salt, 6 g of sugar, and 40 g of ice cubes. The formula of each group is mixed until blended. Four meatball formulations were formed into balls (11g) and cooked in 80÷2˚C water (10 minutes). After the meatballs are floated, they are transferred to water at 100÷2˚C for 20 minutes. Cooked chicken meatballs are drained, put into a container, and labeled according to the treatment group. Chicken meatballs are put into the freezer before being analyzed.

2.4 Fat Content Test Procedure

The procedure for testing chicken meatball fat uses the Soxhlet method: a 5g sample is weighed and placed in a thimble. Place the thimble in a soxhlet extractor and add the hexane solvent. It is extracted for 6 hours. Take out the sample and put the sample in the oven at 105°C (1 hour). The final step is that the sample is weighed. Final weight because to know the amount of fat lost from the remaining fat.

$$\text{Fat content (\%)} = \frac{\text{initial weight - final weight}}{\text{final weight}} \times 100\%$$

2.5 Ash Content Test Procedure

The procedure for testing chicken meatball ash uses the gravimetric method: a 10g sample is put in a cup and weighed. The cup is in put in the oven (525°C) until the sample is white. Cooled in a desiccator and weighed. Calculated ash content with the formula.

$$\text{Ash content (\%)} = \frac{\text{ash weight}}{\text{sample before burning}} \times 100\%$$

2.6 Fiber Test Procedure

The procedure for testing chicken meatballs for fiber content uses the gravimetric method: a 1g sample that has been mashed is weighed and put into a 600ml beaker. After boiling, 100ml of the acidic detergent solution was extracted using an electric heater (1 hour). The extract was filtered using filter paper with the help of a vacuum pump. The residue is rinsed with 300ml of hot water (±3x). The residue was dried in an oven at 105ºC (8 hours). The residue is cooled in a desiccator for 30 minutes and weighed.

Final weight because to know the amount of fiber lost from the amount of remaining fiber.

$$\text{Crude fiber content (\%)} = \frac{\text{residual weight} - \text{paper weight}}{\text{final weight}} \times 100\%$$

2.7 pH Test Procedure

The procedure for testing the pH of chicken meatballs uses a pH meter: 10g of chicken meatballs plus 50 ml of distilled water. Chicken meatballs and distilled water were ground to a fine paste using a laboratory blender. Samples of delicated chicken meatballs were then analyzed for pH. Analysis was measured using a digital pH meter.

2.8 Organoleptic Test Procedure

The procedure for organoleptic testing of chicken meatballs uses the hedonic scale scoring: meatball samples are placed on a coded plate. The hedonic scale scoring used 15 semi-trained panelists. Panelists provide an assessment of texture, color, and taste. All parameters were assessed in a score range of 1-5 (1 = dislike very

much, 2 = dislike, 3 = somewhat like, 4 = like, 5 = really like).

2.9 Microstructure Test Procedure

The microstructure test procedure for chicken meatballs: meatball samples were sliced 1-2mm in size. Samples were added with 2.5% glutar aldehyde in 0.2M phosphate buffer solution (pH 7), and preserved for 2 hours, then washed and soaked in distilled water for 1 hour. Samples were cleaned with ethanol (50%, 60%, 70%, 80%, 90%, and 100% by weight of sample) (after cleaning with ethanol, the samples were cleaned with distilled water, cleaned with ethanol again, and distilled water until so on) for 1 hour. The dried sample is placed on the holder and observed at 3000x magnification.

3. RESULTS AND DISCUSSION

The physicochemical and organoleptic qualities of chicken meatballs using red lentil flour are shown in Figs. 1 and 2.

3.1 Fat Content

Fig. 2 states that chicken meatballs added with red lentil flour did not have a significant effect ($p>0.05$) on the fat content of chicken meatballs. The fat content of chicken meatballs using 6% and 9% red lentil flour meets the requirements for a maximum meatball fat content of 10%, but the fat content of chicken meatballs without adding red lentil flour and adding 3% red lentil flour does not meet the requirements [19]. Meatball fat content requirements. This study's lowest (best) fat-content chicken meatball was chicken meatballs added with red lentil flour 9%. The low-fat content of chicken meatballs is due to the addition of red lentil flour which contains 0.7% fat [15]. The fat content of chicken meatballs decreased because the fat content dissolved during cooking [20].

Fat content affects food texture [21]. Fat affects the appearance and softness of food [22]. Processed foods from meat contain low-fat levels to produce healthy food [23]. Quinoa flour (*Chenopodium quinoa* Willd.) of 7.5% added to chicken meatballs produces the best chicken meatballs with a low-fat content of 80% [24]. The best beef meatballs added with 100% adzuki bean flour (2.11%) produce low-fat beef meatballs [20]. Date palm flour 16% used in beef meatballs has good quality meatballs with a fat content of 3.51% [25].

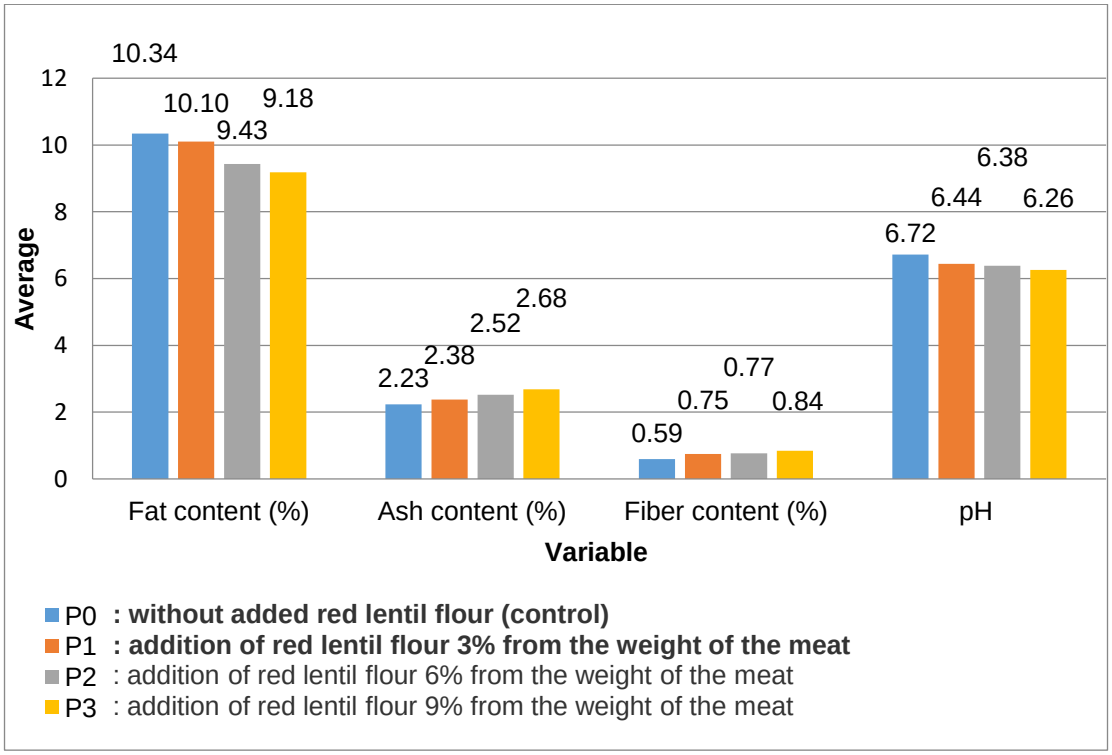


Fig. 1. Physicochemical quality of chicken meatballs using red lentil flour

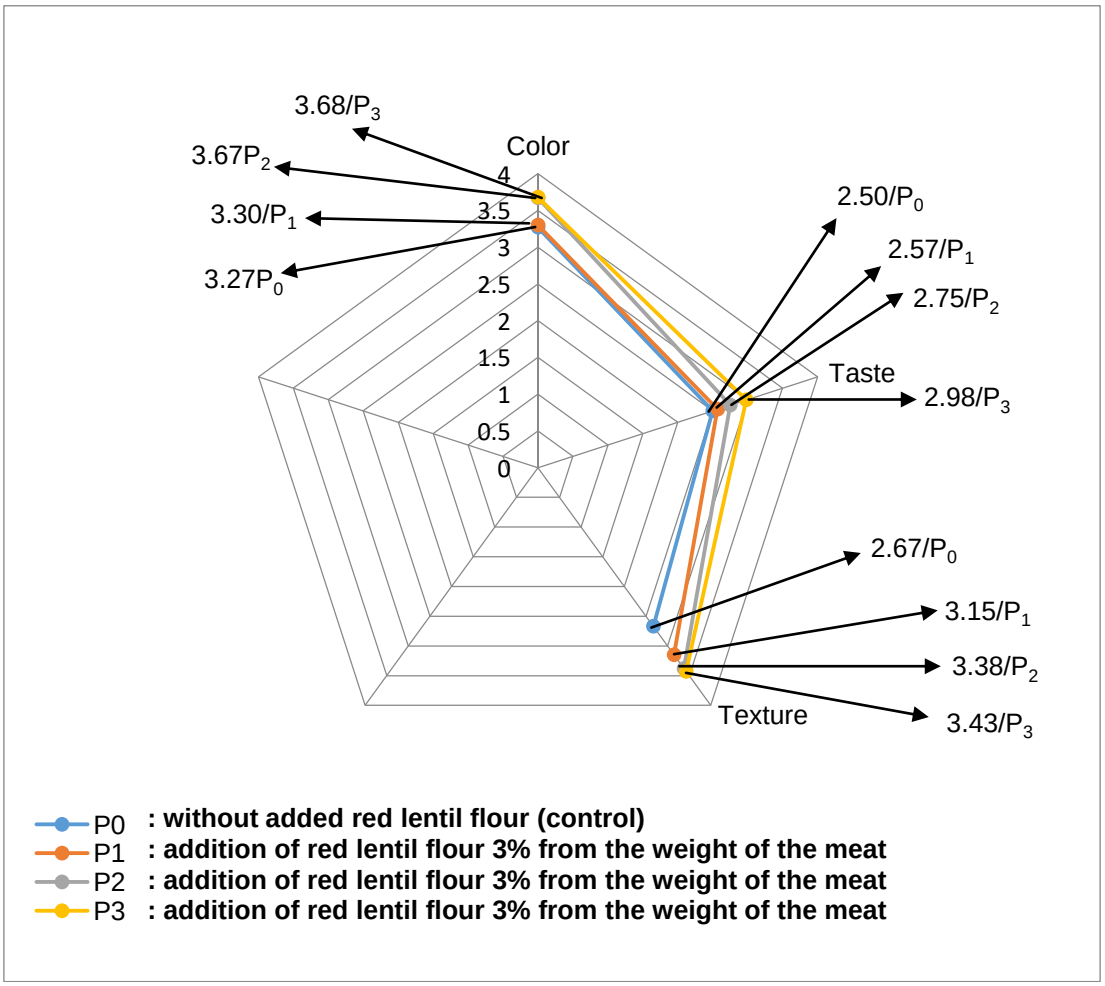


Fig. 2. Organoleptic quality of chicken meatballs using red lentil flour

3.2 Ash Content

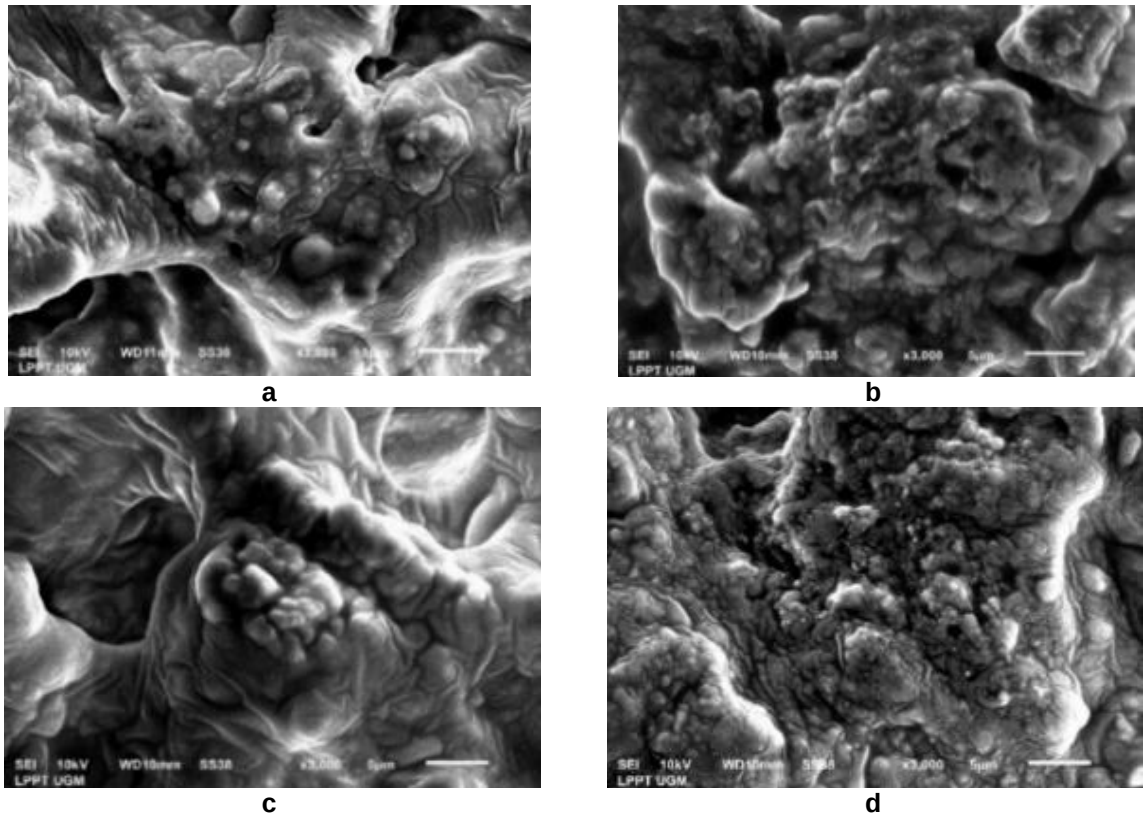
Fig. 2 states that red lentil flour added to chicken meatballs significantly affects the ash content ($p<0.01$). The ash content of chicken meatballs increased with the addition of red lentil flour. The best ash content was chicken meatballs with high ash content, found in chicken meatballs with 9% red lentil flour. Consumers prefer the high and best ash content because it affects maintaining health [26]. The ash content value of chicken meatballs using red lentil flour meets the requirements for meatball ash content, namely a maximum of 3% [19].

Meatballs without added perilla seeds have meatballs with the best ash content of 1.34% [27]. In another study [20], beef meatballs added with 75% adzuki bean flour (*Vigna angularis*) had the best quality meatballs with an ash content of 1.71%. The best beef meatballs without added pumpkin seed flour (*Cucurbita pepo* L.) with an ash content value of 3.91% [4].

3.3 Fiber Content

Based on Fig. 2 above, red lentil flour added to chicken meatballs had a significantly affected pn fiber content ($p<0.05$). The fiber content of chicken meatballs increases with the increasing percentage of red lentil flour, which contains 112.1 g/kg fiber [28]. The results showed that chicken meatballs added with 9% red lentil flour had the best fiber content. High-fiber products benefit human health [27], lowering cholesterol levels, maintaining digestive tract health, and reducing high blood pressure [29]. Fiber reduces blood sugar content [30].

The best beef meatballs added with 16% date palm flour produced a fiber content of 7.93% [25]. Research conducted [31] found that turkey meatballs contained the best levels of fiber with the addition of coarse flaxseed



Picture 1. Microstructure chicken meatballs without adding red lentil flour (picture a), adding 3% red lentil flour (picture b), adding 6% red lentil flour (picture c), and adding 9% red lentil flour (picture d) with 3000x magnification

flour, spinach seed flour, and fine flaxseed flour, each of 8%, with a value of 2.51%. Kirklareli meatballs (a mixture of beef and lamb) using 4% cowpea flour produces good quality meatballs containing 4.80% fiber content [32].

3.4 pH

The pH value affects on meat which ultimately affects processed meat products [33]. Based on Fig. 2, chicken meatballs added with red lentil flour significantly affects the pH value ($p<0.01$). The pH value of chicken meatballs using red lentil flour as a result of the study was within the normal range of meatballs, namely 6 - 7. The pH value of chicken meatballs decreased due to an increase in red lentil flour [34]. The best pH value means that consumers like the product because it is good for health namely 9% red lentil flour added to chicken meatballs [22].

The best pH value of kirklareli meatballs (beef mixed with lamb) using 8% cowpea flour is 6.08 [32]. Pork meatballs using 20% perilla seeds have the best quality meatballs with an increased pH (6.34) [27]. Turkey meatballs using 8% each of coarse flaxseed flour, spinach seed flour, and fine flaxseed flour produce meatballs with the highest pH of 6.25 [31].

3.5 Organoleptic

The organoleptic is used to analyze the sensory quality of products [35]. The organoleptic analysis uses semi-trained panelists and provides an assessment using the hedonic scale scoring [36]. Red lentil flour added to chicken meatballs had a very significant effect ($p<0.01$) on color and taste but had no effect ($p>0.05$) on texture (Fig. 2). According to semi-trained panelists, meatballs added with high red lentil flour produced a darker color and lowered consumer ratings. Chicken meatballs using 9% red lentil flour have the highest and best organoleptic value in color, taste, and texture, meaning they like them the most, and they are the treatment [33].

Beef meatballs added with 25% adzuki bean flour (*Vigna angularis*) produced the best beef

meatballs with brownish-red color, delicious taste, and compact texture [20]. Research by [13] the best chicken meatballs are 5% corn flour (15 days). Pork meatballs added with 10% perilla seeds have good meatballs with the color, taste, and texture that consumers like [27].

3.6 Microstructure

The microstructure of chicken meatballs using red lentil flour mention in Picture 1.

Picture 1 shows that picture (a) the structure of the meatballs has a smooth and wavy surface. Water between the chunks of gel, forms large chunks of gel, forming large spheres because the starch has not gelatinized. Figure (b) Chicken meatballs have a slightly rough surface structure, form small granules, and are spread evenly because the starch has not been gelatinized due to being covered by red lentil flour fibers, forming chunks of gel between spaces surrounded by water. Figure (c), the microstructure of chicken meatballs has a smooth surface by forming a smooth and compact gel, and the presence of water between the surfaces. Figure (d) shows the microstructure of chicken meatballs with a rough surface, the formation of tiny granules that spread evenly due to gelatinization that has not occurred, gel chunks sticking to the surface, and product water starting to decrease.

The results of the microstructure of chicken meatballs with the addition of red lentil flour have similarities to previous studies, namely the structure of the images that are different between treatments. The more percentage of red lentil flour added, the more compact the resulting texture [37]. Chicken meatballs, without added transglutaminase, have a less firm and irregular structure and a rough surface. Chicken meatballs added with 0.5% transglutaminase resulted in a tight gel structure, a more stable and homogeneous tissue structure, and a smooth surface. Chicken meatballs added with 1% transglutaminase formed a surface structure with small grains and rough [17]. Chicken meatballs with meat are directly processed to produce images of a compact gel structure with small uniform cavities. Chicken meatballs with meat stored on ice produce an image structure with slightly large and non-uniform cavities. Meatballs stored at 4°C have a structure with a lot of tissue and large cavities with a non-uniform surface due to water vibrations which damage the structure of the chicken meatballs so that they form a less regular and uniform gel [38]. The microstructure of chicken burgers without added transglutaminase has a loose, irregular, and large gel structure. Chicken burgers added with 0.2% transglutaminase resulted in a compact structure and long and wide cavities. Chicken burger using 0.4% transglutaminase has a small round and irregularly hollow structure. Transglutaminase 0.6% in chicken burgers produces a larger round structure and an irregular surface. 0.8% transglutaminase in chicken burgers produces a thin and flat structure, and adding of 1% transglutaminase produces a compact and dense gel network structure [39].

4. CONCLUSION

The best treatment for chicken meatballs was added with 9% red lentil flour (*Lens culinaris* L.). The best chicken meatballs produce chicken meatballs with sensory qualities such as attractive colors and denser textures. Chicken meatballs are a healthy food because they contain fiber. Consumers can accept chicken meatballs with these qualities. Chicken meatballs with 9% red lentil flour produce chicken meatballs that contain the highest fiber content.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/101083