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Original Article

Improvement of physical and sensory quality of beef patties with the addition of chicken eggshells nanopowder

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Abstract

Objective: The purpose of this study was to investigate the effect of adding chicken eggshells nanopowder for the physical quality and sensory evaluation of beef patties.
Methods: The method used in this study was a laboratory experiment with a completely randomized design with 5 treatments: without adding chicken eggshells nanopowder as a control, adding 0.1%, 0.3%, 0.5% and 0.7% chicken eggshells nanopowder (w/w) with 5 repetitions. Data were analyzed by analysis of variance, if there was a significant or very significant difference it was continued with Duncan's multiple range test.
Results: Based on the research results, it was found that the addition of chicken eggshells nanopowder to beef patties had a very significant effect (P<0.01%) on moisture content, water holding capacity, cooking loss, texture, and sensory evaluation.
Conclusions: The addition of 0.7% chicken eggshells nanopowder can reduce moisture content, increase water holding capacity, reduce cooking loss, improve texture, and sensory quality acceptable to panelists.

Keywords: Beef patties; Calcium; Chicken eggshells; Nanopowder

INTRODUCTION

Patties are processed livestock products using the restructuring method. These food products are made into ready-to-eat food. Generally, patties are used in fast food restaurants and served with bread, vegetables, mayonnaise and sauce. Patties are the result of mixing meat and supporting ingredients which are formed round and flattened. Making patties can use beef, chicken, goat and rabbit [1-4]. Making patties uses 70% meat, 15% ice water, fried onions (40g/kg), fried garlic (20g/kg), and sodium chloride (20g/kg) [32]. The quality of meat burgers has been regulated in Indonesian national standards, which have quality requirements for a minimum protein content of 8% and a maximum fat of 20% [33]. Processing beef into patties is popular with consumers and can extend the shelf life of meat [5]. Patties contain nutrients that are good for the body, but low in calcium. While meat is thought to be a great source of high-quality animal fats, proteins, and B complex vitamins and minerals, it naturally contains less calcium and antioxidants like vitamin E and C [34].

Chicken eggs are a food ingredient that is widely used to make food preparations and to

be consumed directly [6]. The high consumption of chicken eggs will cause an increase in the amount of egg waste. Chicken egg waste is in the form of egg shells in abundant quantities but can damage the environment and cause pollution [7]. Based on the amount of egg consumption in Indonesia, in 2022 the number of egg shells will be 5.6 million tons [8]. Chicken egg shells are a source of calcium and protein that can be utilized by the human body [7].

Calcium is a mineral that plays an important role in bone formation and makes up 99% of bones and teeth. Calcium supplementation is necessary in postmenopausal women and osteoporosis patients due to calcium deficiency [9]. In addition, many people with lactose intolerance require new calcium supplements in the form of fortified foods to meet their dietary requirements [10]. Changes in the shape of egg shells in powder and changes in the size of nanoparticles can add economic value. With a 90% absorbability rate, eggshell calcium is arguably the best natural calcium source.

Nanotechnology is a process that improves the physical-chemical and biological properties of products. Nanoparticles play an important role in increasing the bioavailability of micro components such as calcium [11,12]. Eggshell membranes contain a large number of bioactive components as well as moisture retention and biodegradable properties that can be used in clinical, cosmetic, nutritional and nanotechnology applications [13,14]. The field of nanotechnology is growing rapidly because there are many applications in the manufacture and use of materials that can transform materials into nanoparticles with dimensions below 100 nm [15]. Nanotechnology is not the only technology, but many technologies produce and process engineered or naturally occurring nanoscale materials. The modern development of nanotechnology is enabling new versatile applications in the food formulation and processing, nutritional and functional food industries [15-17].

The addition of chicken eggshells nanopowder to beef patties is because beef patties can be consumed by all ages and people prefer fast food. This study was to determine the effect of chicken eggshells nanopowder on physical quality and sensory evaluation of beef patties.

MATERIALS AND METHODS

Research material

The research material used in this study was beef patties with the basic ingredients of beef thighs (fore shank) from traditional market in Malang City and other ingredients including tapioca flour, egg whites, pepper, onions, garlic, salt, sugar, mushroom broth, and carboxy methyl cellulose (CMC) from avia supermarket in Malang City. Addition of chicken eggshells nanopowder to beef patties according to the treatment. The analysis material used beef patties samples with the addition of chicken eggshells nanopowder with different percentages.

Research methods

A completely randomized design with 5 treatments and 5 replications was used in this study. The treatment carried out in this study was the addition of chicken eggshells nanopowder with different percentages.

Table 1. Formulation of beef patties with the addition of chicken eggshells nanopowder

Ingredients (%)	C	CE1	CE2	CE3	CE4
Beef	70	70	70	70	70
Ice cube	12	12	12	12	12
Tapioca flour	10	10	10	10	10
Garlic	1.125	1.125	1.125	1.125	1.125
Onion	2.25	2.25	2.25	2.25	2.25
Salt	0.75	0.75	0.75	0.75	0.75
Egg whites	0.75	0.75	0.75	0.75	0.75
Powdered white pepper	0.75	0.75	0.75	0.75	0.75
Mushroom broth	0.75	0.75	0.75	0.75	0.75
CMC	0.75	0.75	0.75	0.75	0.75
Chicken eggshells nanopowder	**0**	**0.1**	**0.3**	**0.5**	**0.7**

Without adding chicken eggshells nanopowder as a control (C), adding 0.1% (CE1), 0.3% (CE2), 0.5% (CE3), and 0.7% (CE4) (w/w) chicken eggshells nanopowder. Beef patties formulation with the addition of chicken eggshells nanopowder can be seen in Table 1.

Chicken eggshells nanopowder preparation

Egg shells were obtained from one of the bakery industries in Malang City. The eggshells are cleaned using running water and the white coating that sticks to the inside of the eggshells is removed. Put water in a saucepan and heat it until it boils. Place the egg shells in boiling water at 100°C and boil for ± 30 minutes. The finished eggshells are boiled, removed, drained, and dried for 3 hours.

Egg shells are prepared on a baking sheet that has been lined with parchment paper and the egg shells are arranged upside down. Put in the preheated oven, with a heating temperature of 80±2°C for 120 minutes. The egg shells that have been baked will be drained and left to stand for 1 × 24 hours. Egg shells were mashed in 2 stages, stage 1 mashed with mortal to reduce the size and stage 2 mashed with a dry mill to have a flour-like texture. The smooth eggshells were sifted using a 300 mesh sieve. Chicken eggshells nanopowder is ready to be applied to food products [7].

Beef patties with the addition chicken eggshells nanopowder preparation

Patties are made from beef thighs. Meat is cleaned with running water. Beef is cut into small squares measuring 2 × 3 × 2 cm. Beef that has been cut into cubes is ground using a meat grinder and added to ice cubes and mixed for 20 seconds. Then the other ingredients are added, that is tapioca flour, egg white, pepper, onions, garlic, salt, sugar, and mushroom broth. The last ingredient added was chicken eggshells nanopowder according to the specified treatment, that is 0%, 0.1%, 0.3%, 0.5% and 0.7%. The dough is then weighed and pressed against a mold to form patties of equal size. Beef patties dough with chicken eggshells nanopowder is steamed for 5 minutes. Beef patties that have been cooked are drained and cooled then grilled over low heat.

Variable measurement

Moisture content was measured using the oven drying method. Water holding capacity is measured by placing a load of 45 kg on a sample that is enclosed in glass. Cooking loss was measured by boiling the sample in a water bath for 30 minutes. Texture analysis using texture analyzer (The Brookfield CT-3) and the samples were obtained cutter 2.5 cm × 1.5 cm of height and then the evaluated parameters was hardness (N). Sensory evaluation using 5 trained panelists using hedonic tests. The score given is 1 (don't like it very much) to 5 (like it very much).

Data analysis

Statistical analysis was performed using analysis of variance (ANOVA) to determine the effect of the chicken eggshells nanopowder treatment. Statistical analysis was performed using IBM SPSS v.25 (IBM SPSS, Chicago, Illinois, USA). Duncan's multiple range test at 1% significance level.

RESULTS

Moisture content

The results of the analysis of the variety of beef patties with the addition of chicken eggshells nanopowder had a very significant effect ($P<0.01$) on moisture content. The average moisture content of chicken patties ranges from 45.22–46.84%. CE3 has a lower moisture content compared to other treatments. Table 2 presents the results of the research on the average moisture content in beef patties with the addition of chicken eggshells nanopowder.

Water holding capacity

The results of the analysis of the variety of beef patties with the addition of chicken eggshells nanopowder had a very significant effect ($P<0.01$) on the water holding capacity. The average water holding capacity of chicken patties ranges from 64.50–65.53%. CE3 has a higher water holding capacity compared to other treatments. Table 2 presents the results of the research on the average water holding capacity of beef patties with the addition of chicken eggshells nanopowder.

Table 2. Average physic quality in beef patties with the addition of chicken eggshells nanopowder

Treatment	Moisture content (%)	WHC (%)	CL (%)	Texture (N)
C	46.84^{b}±0.03	64.50^{a}±0.33	5.02^{c}±0.11	12.90^{a}±0.01
CE1	46.34^{b}±0.32	64.69^{a}±0.07	4.79^{bc}±0.05	13.00^{b}±0.02
CE2	46.11^{a}±0.56	64.78^{a}±0.04	4.71^{bc}±0.04	13.07^{b}±0.02
CE3	45.37^{a}±0.24	65.27^{b}±0.14	4.59^{b}±0.07	13.11^{c}±0.02
CE4	45.22^{a}±0.18	65.53^{b}±0.09	4.36^{a}±0.05	13.31^{d}±0.06

Without adding chicken eggshells nanopowder as a control ©, adding 0.1% (CE1), 0.3% (CE2), 0.5% (CE3), and 0.7% (CE4) chicken eggshells nanopowder. Different superscripts in the same column show a highly significant difference (P<0.01).

Table 3. Score sensory quality of beef patties with the addition of chicken eggshells nanopowder

Treatment	Color	Flavor	Aroma	Texture	Acceptance
C	3.00^{a}±0.46	3.30±0.86	3.05^{a}±0.60	3.20±0.52	3.70±0.47
CE1	3.55^{a}±0.50	3.85±0.50	3.35^{a}±0.50	3.35±0.50	3.40±0.82
CE2	3.90^{a}±0.58	4.45±0.50	3.95^{a}±0.96	3.60±0.82	4.65±0.50
CE3	4.55^{b}±0.50	4.70±0.58	4.50^{a}±0.58	4.45±0.50	4.35±0.50
CE4	4.65^{b}±0.50	4.75±0.50	4.65^{b}±0.96	4.70±0.58	4.60±0.82

Different superscripts in the same column show a highly significant difference (P<0.01).

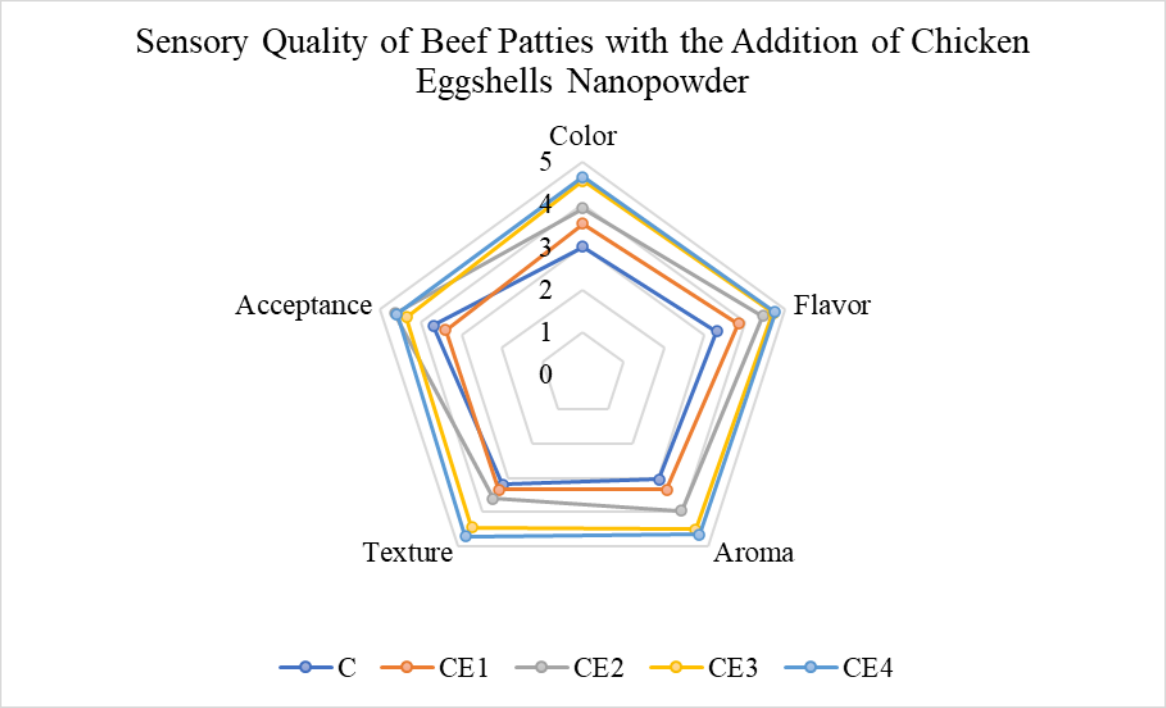

Figure 1. Spider graph sensory quality of beef patties with the addition of chicken eggshells nanopowder

Cooking Loss

The results of the analysis of the variety of beef patties with the addition of chicken eggshells nanopowder had a very significant effect (P<0.01) on cooking loss. The average cooking loss of chicken patties ranges from 4.36 – 5.02%. CE3 has a lower cooking loss compared to other treatments. Table 2 presents the results of research on average cooking loss in beef patties with the addition of chicken eggshells nanopowder.

Texture

The results of the analysis of the variety of beef patties with the addition of chicken eggshells nanopowder had a very significant (P<0.01) effect on texture. The average moisture content of chicken patties ranges

from 12.90–13.31 N. C has a lower texture compared to other treatments. Table 2 presents the results of the average texture study on beef patties with the addition of chicken eggshells nanopowder.

Sensory quality

The results of calculations and analysis showed that the addition of chicken eggshells nanopowder to beef patties with different percentages had a very significant effect ($P<0.01$) on the sensory evaluation of color and aroma. The score sensory quality of beef patties with the addition of chicken eggshells nanopowder can be seen in Table 3 and shown in the spider graph in Figure 1.

DISCUSSION

Moisture content is an important parameter of a food product to determine product quality. The lower the moisture content, the lower the growth of microorganisms. The greater the percentage of chicken eggshell nanopowder can reduce the moisture content in the patties. The more addition of shell flour to the nuggets causes the water content to decrease [18]. Other supporting research is that shell flour is polar and can prevent water absorption and can be manipulated in aqueous solutions [19]. Thus, the more beef patties added with chicken eggshells nanopowder the lower the water content. Calcium has the property of being able to decompose water, so that calcium will form cations that is Ca^{2+} in aqueous solution [20]. Ca can bind to OH from H_2O and stable H bonds are bound to Ca-OH groups thereby limiting the mobility of water and resulting in decreased water content [21]. The property of calcium in chicken eggshells nanopowder to break down water and bind OH to H_2O causes the water content of beef patties to decrease.

The water holding capacity of beef patties with the addition of chicken eggshells nanopowder increases with the increase in the percentage of addition. Calcium contained in chicken eggshells nanopowder can help increase the water holding capacity of beef patties. OH in water can be bound by Ca to form CaOH bonds, stable bound H ions will help reduce the mobility of water [21]. Wheat bran cellulose is rich in protein which can bind water and stabilize water levels [22]. The protein in meat and chicken eggshells nanopowder affects the water binding process, so that the water holding capacity can be increased in beef patties. In a previous study, the water holding capacity of beef sausage with fortified duck egg shell flour decreased due to loss of protein during the cooking process [23]. Calcium can attract water molecules from within the material to form hydrates and the texture will also be more compact [31].

Cooking loss produces data that is inversely proportional to the water holding capacity. If the water holding capacity increases, the cooking loss value will decrease. Cooking loss is influenced by the ingredients used and is indicated by the weight lost in the cooking process. The more addition of chicken eggshells nanopowder to the beef patties, the lower the cooking loss will be. This is influenced by the protein in beef and chicken eggshells nanopowder. Denatured protein caused by heat inactivation will affect cooking shrinkage [24]. In addition, there is a NaCl bond in the salt used with meat components [25]. Sodium chloride can maintain protein stability, so that proteins can maintain their ability to bind water [26].

Beef patties with the addition of chicken eggshells nanopowder produces an increasing texture value. The addition of eggshell calcium powder and gelatin to turkey steaks makes the meat more supple [27]. Meat treated with the addition of insect protein and eggshell powder showed a decrease due to the addition of insect protein which inhibited gel formation in meat [28]. The addition of chicken eggshells nanopowder to beef patties produces a more chewy texture in direct proportion to the more addition of chicken eggshells nanopowder. In addition, the resulting texture can be influenced by the calcium content in the chicken eggshells nanopowder. Chicken eggshell is a good source of calcium and antioxidants for the body [9].

The sensory quality of beef patties with the addition of chicken eggshells nanopowder was acceptable to all panelists. There was a significant difference in the color and aroma of the beef patties ($P<0.01$). Beef patties sensory qualities include color, taste, aroma, texture, and level of acceptance. Overall beef patties

with the addition of 0.7% chicken eggshells nanopowder showed an increase in color and aroma. The color of the beef patties increased the darker it was compared to the control treatment. This is because the more addition of chicken eggshells nanopowder produces a dark red color. Eggshell powder tends to have a dark color so that it lowers the brightness compared to the control [29]. The taste of beef patties with chicken eggshells nanopowder has an after taste, dry spots left on the tongue. However, this addition provides a new sensation for the panelists in consuming beef patties. The aroma of the beef patties produced is still dominant in the aroma of beef and onions used. Chicken eggshells nanopowder doesn't have a pungent smell, but has a phenol or smoky smell that is produced as a result of the heating process in the oven. The aroma produced by egg shell is a slightly smoky aroma [30]. Beef patties with chicken eggshells nanopowder produce a chewy texture and panelists judged that when chewing, the texture was soft and easy to chew. The fine powder produced by chicken eggshells nanopowder has a textural effect on beef patties. The level of panelist acceptance of beef patties with the addition of chicken eggshells nanopowder the more the percentage of addition, the more favored by the panelists including the color which tends to be darker, the taste with the appearance of after taste, the aroma of smoke that appears on the beef patties, and the texture which is chewy and soft when chewed.

CONCLUSION

The addition of chicken eggshells nanopowder as a source of calcium and protein in the beef patties formulation as much as 0.7% can improve the physical and sensory qualities of the beef patties. The development of chicken eggshells nanopowder can be carried out for application in food products as a source of calcium. In addition, it is necessary to carry out a feasibility test for future storage.

CONFLICT OF INTEREST

All authors expressed no interest in competing. Everything is done to be useful to others.

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