The Application of Whey Edible Film Coating With Addition of Lemongrass Essential Oil on Halloumi Cheese during Storage

Maftuh Kafiya[1*], Danar Wicaksono[2], Khairunnisa Luthfi Nurulhuda[1], Siti Mahmudah Nur Hidayati[1]

[1]Department of Agribusiness, Faculty of Agriculture, Universitas Pembangunan Nasional "Veteran" Yogyakarta
Jl. Padjajaran, Condong Catur, Depok, Sleman, Indonesia
***Correspondence** : E-mail: kafiyamaftuh@upnyk.ac.id, Phone +628197219466
[2]Department of Agrotechnology, Faculty of Agriculture, Universitas Pembangunan Nasional "Veteran" Yogyakarta
Jl. Padjajaran, Condong Catur, Depok, Sleman, Indonesia

ABSTRACT

The effect of whey edible film with the different concentrations of lemongrass essential oil with halloumi cheese shelf life was investigated. This study aims to examine the physical characteristics of halloumi cheese to the application of edible film whey with the addition of lemongrass essential oil as an antimicrobial, especially fungal attacks during storage. The experiment was designed with a complete randomized design (RAL) with 3 repeats consisting of 5 concentration treatments of lemongrass essential oil, namely halloumi without film (P0), edible film whey control (P1), edible film whey + 0.1% essential oil of kitchen lemongrass (P2), edible film whey + 0.5% essential oil of kitchen lemongrass (P3), and edible film whey + 1% essential oil of kitchen lemongrass (P4) with storage in a room (temperature 28.5 C; RH 61%). The results showed that cheese coated with edible whey film with the addition of essential oils of kitchen lemongrass P3 and P4 was able to extend the shelf life of halloumi cheese up to 6 days with a moisture content of 21.34% and 32.27%, respectively. The hardness of halloumi cheese decreased during storage. The identification of the fungus found in halloumi cheese during the storage process is Aspergillus sp.

Keywords: *edible film, lemongrass essential oil, storage of halloumi*

INTRODUCTION

Halloumi cheese is classified as a semi-hard cheese from Cyprus and it made from sheep's milk or goat's milk and or a combination of the two. Meanwhile, in Indonesia, halloumi cheese is mostly made from cow's milk according with the preferences Indonesian consumers. Halloumi cheese can last up to 2 months with vacuum packaging and stored in a chiller at a temperature of 2-5^{o}C. When it is opened from the package, the cheese tends to only last for 1 to 2 days. Therefore, technology is needed to extend the shelf life of cheese after it has come off with primary packaging.

Cheese processing has a side product, it is whey which is a clear liquid from curd filtering and pressing process. 85% to 90% of the volume of milk which is used to cheese processing produces a by-product, whey (1). In fact, the whey is thrown away without further processing as a form of utilization. Even though the nutrients contained in whey are still there, 5% lactose, 1% protein, 0.4% fat and several other minerals that can still be used as one of the functional foods in the form of drinks, biodegradable packaging (2), edible film (3) and others.

Many study investigated the potential use of whey to form edible films and coatings. Edible film have ability to control mass transfer between the food and its environment, it used to improve food appearance and preservation to extend shelf-life product (4). The properties from whey edible film are transparent, soft, flexible, colorless, and have aroma-

retaining from the food products they are coated with (5). However, edible film from whey have high hydrophilic ability, so it has less to maintain the evaporation of water from the product. Beside that, the natural raw materials have unstable content and easier to contamination. This weakness can be overcome by heating treatment and need additional material to increase the ability of edible films.

The combination of antimicrobial with edible film is able to control microbial growth in food and extend shelf life and improve food quality. Edible antimicrobial film is able to control the diffusion and release of antimicrobial agents above the surface of food during the storage process (6). Lemongrass (*Cymbopogon citratus*) or West Indian Lemongrass is one of the plant that can produce essential oil that can be an anti-fungal and antibacterial. Lemongrass essential oil containing sitronelal about 36,11%, geraniol 20,07% dan sitrinelol 10,82% (7), which is in other studies results that geraniol can inhibit the growth of *Aspergillus* sp. in vitro study (8).

To the best of our knowledge, there has been no research reporting the effect of whey cheese based edible coating incorporating conjugated lemongrass essential oil during storage of halloumi. Therefore, the aim of this study was to investigate the effect of whey based edible film containing lemongrass essential oil as antimicrobe on the physical properties of halloumi cheese during storage in room.

MATERIAL AND METHODS

This experiment used fresh whey (pH 5,5) and halloumi obtained from PT. Rumah Keju Jogja, Sleman, Yogyakarta, Indonesia. Coagulant or rennet was provided by Danisco (USA). The lemongrass essential oil produced by Rumah Atsiri (Indonesia). Other ingredients used are palm oil, tween 80, destilated water, glycerol, $CaCl_2$, CMC and PDA.

Cheese processing

In the tradition Halloumi-making process no heat treatment is applied. Poured the rennet 0,027% of raw milk at temperature 34^{o}C. Stirred and left to settle to be coagulum. After 45 minutes coagulum was cut into cubes (1-2 cm^3) and filled into mold then pressed with a load so that the whey flows down faster. The whey was filtered and stored in freezer which is used as raw material for edible films. Cut the drained curd blocks and boil in water reached 100^{o}C for approximately 40-45 minutes. Each curd was then removed and soak in brine for 2-5 days and stored at 2-5^{o}C. All cheese were drained and packed in plastic box.

Preparation of Edible Film

The process of making edible film is the result of modification (9) (10), 10 ml whey from PT. Rumah Keju Jogja has filtered using Whatman 41 and then added 2,5 ml gliserol, 30 ml distilled water, 15% tween 80, 4 ml palm oil, and 0,25%$CaCl_2$. Lemongrass essential oil was added with concentrations of 0.1%, 0.5%, and 1% then heated at 60^{o}C for 15 minutes using water bath. Then add CMC to the solution until it is shaped like a dough. After the dough is formed, the edible film is formed using a spreader with a size of ±1 ml continues with the drying process at a temperature of 60 ^{o}C for 24 hours.

Storage cheese

Halloumi stored in room with temperature 28,5^{o}C and relative humidity 60% at 3,6,9 and 12 days. Representative samples were prepared according to determine moisture content using thermogravimetri method (11) hardness using penetrometer, and isolated and identify fungi in cheese. The other representative samples used to observation of the appearance spoilage in cheese during storage.

Isolation and Identification of fungal

Identification was based on the visual observation of fungal isolates grown on PDA by morphological characteristics. PDA that was ready to be thawed using a microwave for 5 minutes was then printed on a petri dish. Scraping of halloumi surface to get the contaminate fungal was taken for isolation. The fungal planted on the PDA and observed until the fungus appeared (5 days). The results are matched with the literature based on the characteristics.

The research used a completely randomized design with three replications. The data were then analyzed using analysis of variance (ANOVA) at 0,05 significance level and differences in the mean values were determined with Duncan's (DMRT) to determine the differences among concentration treatment. SPSS Statistics 16 program was used for statistical analysis.

RESULT

Result of the moisture content halloumi are summarized in Table 1. The moisture content showed the content of free water and bound water contained in cheese. The moisture content of halloumi decreased in all treatments during storage. The moisture content of cheese is the important component in food because it can affect appearance, texture, and flavor of food.

Table 1. Moisture Content Halloumi during Storage

Days	P0	P1	P2	P3	P4
0	44,72a	43,93a	44,57a	43,42a	44,45a
3	41,41b	33,32a	34,77a	29,16a	33,31a
6	x	x	x	21,34a	32,27b
9				x	36,61
12					x

x : spoilage
P0 : Non Film
P1 : *edible film whey control*
P2 : *edible film whey + 0.1% essential oil of kitchen lemongrass*
P3 : *edible film whey + 0.5% essential oil of kitchen lemongrass*
P4 : *edible film whey + 1% essential oil of kitchen lemongrass*

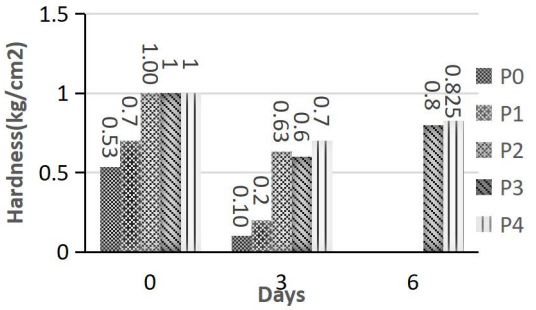
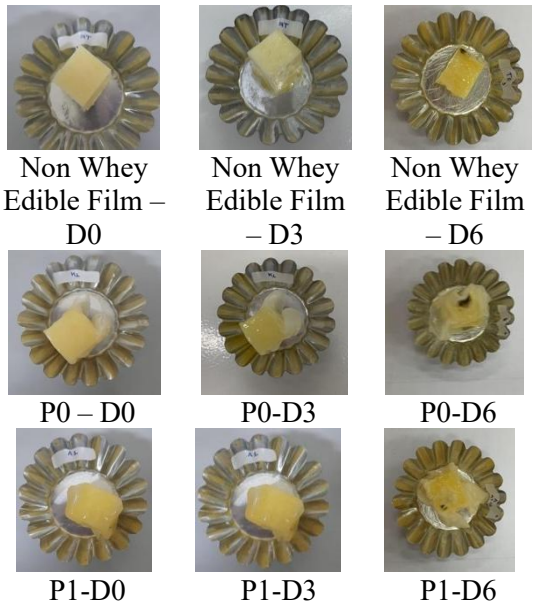


Figure 1. Hardness of Halloumi during Storage

Hardness is the force required to press the cheese to the point penetration (12). The unit of value used is indicates the force to entering the sample. The result of the hardness analyses during storage are showed in figure 1.

The appearance of halloumi cheese in all treatment during storage are showed in figure 2. Meanwhile the appearance isolation the fungi in halloumi cheese are showed in figure 3 as isolate 1, figure 4 as isolate 2 and figure 5 as isolate 3.



Non Whey Edible Film – D0 | Non Whey Edible Film – D3 | Non Whey Edible Film – D6

P0 – D0 | P0-D3 | P0-D6

P1-D0 | P1-D3 | P1-D6

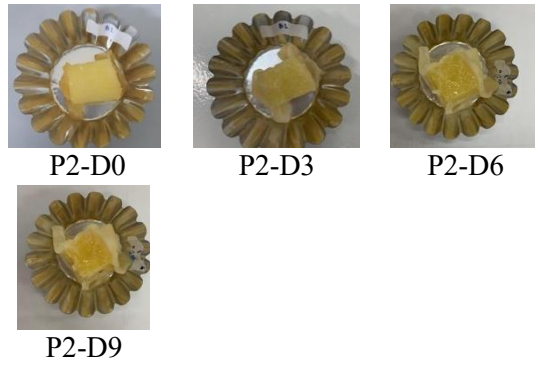


Figure 2. Figures Appearance of Halloumi during Storage

Figure 3. Isolate 1 *Aspergillus* sp.

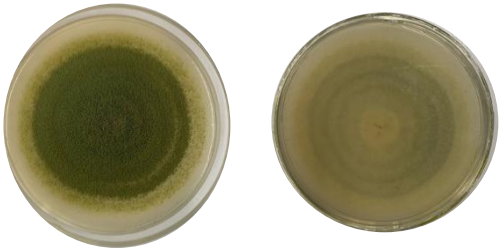


Figure 4. Isolate 2 *Aspergillus* sp.

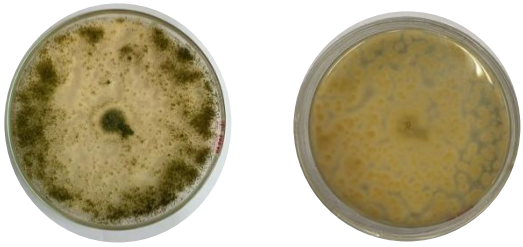


Figure 5. Isolate 3 *Aspergillus* sp.

DISCUSSION

Fresh halloumi is made from curd produced by curdling milk with rennet. According to the Cypriot Standards (13), halloumi cheese should a maximum moisture content of 46%, the result of research is about 44,72% ± 4,66. The results of the study on the moisture content value of halloumi cheese coated with edible whey film can be seen in Table 1. The coating of edible whey film with the addition of antimicrobial lemongrass essential oil did not show any significant different for moisture content in beginning storage. Meanwhile, in the next storage, the moisture content of halloumi decreased significantly ($P<0.05$). Edible coating is a method to inhibit the release of gas, water vapor and avoid directly contact with oxygen (14). Edible films have a permeable membrane that can reduce the level of respiration and lemongrass essential oil acted as hydrophobic component in the layer of edible films so that the moisture content of halloumi on the treatment P4 are smaller than the treatment of P5 on 6 days time storage.

However, the addition of the concentration of lemongrass essential oil at a concentration of 0.5% and 1% has been able to extend the shelf life of up to 6 days of storage. Under normal processing conditions, vacuum packaged Halloumi cheese has a shelf life of 3–7days at20–25 ^{o}C or 40–80 days at 4–58 ^{o}C (15).

The hardness of cheese is affected by the moisture content in cheese. The matrix that has a higher water content has a softer texture (16). Figure 1 gives information about level of hardness halloumi during storage. The level of hardness halloumi during storage results in a decrease level of hardness, it means that the halloumi has softer texture. The highest of hardness is P2, P3 and P4, which makes up 1 kg/cm^2 in beginning of storage. Whey protein produces films with

barrier properties to the aroma, oil, oxygen, and adequate mechanical properties to provide resistance when used as a film or coating for packaging applications (17).

In appearance of halloumi during storage (Fig. 2) showed that the halloumi P0, P1 and P3 appeared fungi in 6 days, with symptoms of the appearance of darks spots on the surface of halloumi. Meanwhile in treatment P3 and P4, the fungi appeared in 9 days and 12 days. However, the other study about shelf life of halloumi have been reported that the dramatic drop in the shelf-life of the product stored at 25°C to 2.6 days was caused by detrimental changes in the cheese appearance. So it needs to maintain low temperatures during the product distribution and display (15). Meanwhile, in this experiment the whey edible film can extend shelf life because whey edible film composite containing antimicrobial agents can inhibit the release of antimicrobial substances into the food (3). The application of whey edible film with antioxidants and antimicrobials can increase food safety and shelf life of products (17).

Microbial contamination of cheese surfaces during storage are considered the main reasons for early shelf-life termination of halloumi cheese. In figures 3 showed that the cultural characteristics of the fungal isolates were heads dark brown, greenish black. The fungal isolates 2 and 3 (Fig 4 and fig 5) showed that the colonies were yellow green. The fungal contamination of Egytptian Ras cheese (including Egyptian cheese) was studied by El-Fadaly, et.al. (19), who found that, 6 genus and 13 species as following *Geotrichum candidum*, *Aspergillus ochraceus*, *A. alliaceus, A. oryzae, A. niger, A. nidulans, Emericella nidulans, A. flavus, A. glaucus, A. flavipes, Penicillium sp., Mucor* sp. and *Rhizop*us. From this characteristics and following the protocol of El-Fadaly et.al. (19) the fungal that found was similar with *Aspergillus* sp.

CONCLUSION

It can be concluded that, the moisture content of halloumi decreased significantly ($P<0.05$). Cheese coated with edible whey film with the addition of essential oils of kitchen lemongrass P3 and P4 was able to extend the shelf life of halloumi cheese up to 6 days with a moisture content of 21.34% and 32.27%, respectively. The hardness of halloumi cheese decreased during storage. The identification of the fungal that found in halloumi cheese during the storage is Aspergillus sp.

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