Quality characterization of “wingko” traditional food by applying vacuum packaging in a tropical environment

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Abstract. Wingko is a traditional snack food that popular as a souvenir food which made from coconut with flat round shape, and its affected by tropical environment on quality and shelf-life of food. Objective of the research was to know the effects of vacuum packaging on quality characterization of traditional wingko food. Home wingko industry in Kotagede Yogyakarta was produced sample wingko food, then, it re-packaged using polyethylene plastic with nylon and applied vacuum with difference amount of food, for vacuum single, six and twelve food using low concentration of oxygen. Lastly wingko food without packaging as control. Several physicochemical quality parameter were analysed using standard method such as water content, free fatty acid content, pH, hardness of food, color of food and microorganism growth using yeast and mould value. Based on the result, we found that vacuum packaging can be maintained the quality of wingko food during their storage compare with that on control in every treatments with single, six and twelve products in vacuum packaging. Rancidity and mould can be depressed their growth during wingko food stored using a vacuum with packaging. Vacuum packaging treatments have a good impact on maintaining quality and extending shelf-life of the products.

1. Introduction
Wingko is one of the traditional snack food that historically form Babat, Lamongan, East Java, then it become popular as a souvenir food in Semarang Central Java and Yogyakarta and it made from coconut, glutinous rice flour and sugar for soggy food that have a with flat round shape. This product usually a home-made industry and have a texture, aroma and special taste that consumer like [1]. Hadibroto [2] said that wingko have a short period of shelf-life and easy to be defected around 2-4 days after production, with the main indicators for visually detected such as a growth of microorganism or mold will detect, rancidity and slimy. Growth and bacterial activity in the surface of the food could be produced extracellular enzyme that will affected the product will be watery, slimy and smelly [3]. Trisnawati dan Purwidiani also said [4] that wingko that have 10% fatty content can be easily to be rancid in the room tropical environment, this process could be occurred caused of fat oxidation during product storage in the room temperature [5].

Wingko’s product that sale in the market, commonly using primary packaging from paper glassine or grease proof paper because of the ability of the paper to absorb oil or fat of the product and easily to be change the shape. Unfortunately, this glassine paper have a little big porous that caused low permeability with water and gases. This condition can be affected the quality and shelf-life of the wingko during their storage in the market, and the tropical environment will accelerate food quality deterioration. Packaging material and process can be used as an alternative to retard environmental effects such as temperature and humidity to the wingko’s food product. Packaging properties and
processes can be affected and protected the food product and then it will increased the shelf-life and maintained their quality [6]. Vacuum packaging technique was proven to retard decreasing quality of the whole smoked skipjack fish [7], to retard microbial growth of whole smoke chicken[8], African cheese [9], Turkish cheese [10] sliced bread [11] and can retard microbial growth, oxidation process and color change of meatball [12].

Objective of the research was to identification the effects of vacuum packaging application on quality characterization of traditional wingko food. Application of the vacuum packaging on the wingko’s traditional food will be expected can be applied and be protected the product from unfavorable tropical environment that can retard quality deterioration of the product and then product of wingko in the future can expand their market due to their ability to maintain the quality and increase their shelf-life.

2. Materials and method
Sample of Wingko Babat was produced from Wingko Plesir Home Industry located in Pandeyan, Umbulharjo, Yogyakarta city. Firstly, production of Wingko was raw materials preparation that consist of glutinous flour rice, raw coconut, sugar, butter and coconut water, then this materials was weight using balance for each proportion of composition. Next step was mixing all materials using a mixer until evenly mixed and it make homogenous batter and ready to form in mold as flat round shape using bamboo mold with diameter 5.5 cm and thickness 1.8 cm. Batter was ready to grill using closed stove until cooked for around 30 minutes with a yellow brown color on surface of the wingko. Then, the wingko food with diameter 5.5 cm and thickness 1.2-1.5 cm was put into the baking sheet in the room for cooling for around 30 minutes and then it will covering with paper glassine in the box from paper as primary and secondary packaging. A box of wingko packaging have 12 pieces and wingko was ready to distribute to the market.

2.1. Packaging treatments
Wingko food from the industry was re-packaged based on the treatments for measurements. Packaging materials were used plastics packaging film from combination of polyethylene film with nylon using thickness from 75 -80 micron as a primary packaging. Vacuum processing was using vacuum sealer machine (Sayota Sinbo, DZ-280/2SD, China) which absorb aerial inside packaging until condition of oxygen concentration around 0-3%. First treatment was single wingko food which vacuum using plastic vacuum bag with size of  8 x 12 cm for thickness 75 micron, second treatment was six wingko food which vacuum using plastic vacuum bag with size of 15 x 20 cm for thickness 75 micron and third treatment was twelve wingko food which vacuum using plastic vacuum bag with size of 18 x 28 cm for thickness 80 micron. Wingko food without vacuum packaged film for twelve pieces in a box was used as a control. All treatments and control were put in the room without controlled temperature and relative humidity. Figure 1 show the each treatment and control below.

![Figure 1. Packaging treatments of wingko food; (K) control of wingko food without packaging; (P1) single wingko food using vacuum plastic packaging with thickness 75 micron; (P2) six wingko food using vacuum plastics packaging with thickness 75 micron; (P3) twelve wingko food using plastic vacuum packaging with thickness 80 micron.]
2.2. Quality parameter for measurements
Physico-chemical quality parameter were determined with different treatments that mentioned above such as water content, free fatty acid content, pH content, and texture of surface color), microorganism content on growth of yeast and mold and also visually using simple organoleptic (appearance, texture and color). Water content was measured using standard thermo-gravimetry method [13]. Content of pH of product was determined using pH meter (H12210, Hanna Instrument, Switzerland) and free fatty acid content of wingko was analyzed using titration method of Mehlenbacher [14], then texture of surface of wingko mas measured using texture analyzer (FHT-200 Extech, Taiwan). Growth of microorganism on wingko was analyzed using standard of yeast and mold test [14]. Sampling preparation and quality measurements were analyzed in Laboratory under Department of Agroindustrial Technology Faculty of Agricultural Technology Universitas Gadjah Mada.

2.3. Statistical analysis
Data obtained from the experiment results were tabulated and calculated using Microsoft Excel 2010 (Microsoft Corporation) and then statistical analysis for Duncan’ test with 95% significance level were used to compare average data resulted from three group treatments and they utilized using SPSS version 23.0 (SPSS Incorporation).

3. Result and discussion
Home industry wingko Plesir was produced wingko as sample using conventional and manual method for the production processed that mentioned above, where one of the disadvantage was the standardize of the raw materials, processing and finished product still to be considered for homogeneity of the product quality. On the other hand, finished product of wingko that produced was still similar with the common wingko using paper glassine for primary packaging in the box that sale in the market.

Based on the treatments which have applied to the packaging conditions, parameters of wingko’s quality can be shown as the effects on water content, pH content, free fatty acid content, texture of surface or hardness of products and yeast and mold value, respectively. Then, visually of the wingko also will be shown. Figure 2 show the water content of the wingko under different packaging treatments. Water content of wingko food have relatively medium content of water which normally around 25-30% then it include a soggy food. Water content of wingko food have stable condition under different packaging treatments, these packaging treatments could be protected aerial tropical environment compare with the control without vacuum packaging, which have decreasing the water content during storage for several days, although at 7th days there was an anomaly for the data. Packaging treatments using polyethylene plastics can be acted as chemical and biological barrier for water or moisture transport form outside packaging or aerial environment as main functions of packaging [15]. Water is omnipresent in food stuffs and the surrounding atmosphere, determination of water content is one of the most frequent analysis in the laboratory of a food industry, where mobility of water and its availability for biochemical reactions depend on the type of interaction, and then extending the shelf-life of a food product consists in preventing its degradation by biochemical reactions or microbial growth [16].

Figure 3 shown pH content of wingko food under different packaging treatments for several days storage. pH content were relatively similar between the wingko food with packaging treatments and control without packaging, this indicate that pH were not affected directly by the different condition of with or without packaging on the wingko food, which short time period could not affected common indicator of pH to the food such as acidity, color, growth and mortality of microorganism inside of products.
Figure 2. Water content of wingko product under different treatments for several days packaging treatments; K is a control of wingko without any treatments; P1 is single wingko food using vacuum plastic packaging with thickness 75 micron; P2 is six wingko food using vacuum plastics packaging with thickness 75 micron; P3 is twelve wingko food using plastic vacuum packaging with thickness 80 micron. Data was average from 3 wingko food with double replication measure.

Figure 3. pH content of wingko product under different treatments for several days packaging treatments; K is a control of wingko without any treatments; P1 is single wingko food using vacuum plastic packaging with thickness 75 micron; P2 is six wingko food using vacuum plastics packaging with thickness 75 micron; P3 is twelve wingko food using plastic vacuum packaging with thickness 80 micron. Data was average from 3 wingko food with double replication measure.

Figure 4 show free fatty acid (FFA) content of wingko food under different packaging treatments. FFA content of wingko food under different packaging treatments were relatively similar value from first day until fifth day after packaging treatments compare with the control. FFA content for all condition were relatively increase gradually during storage for several days under different packaging treatments, these condition were appear in the surface of wingko food which it look like covering surface with oily and water and tend to be slimy. Oily and watery of wingko food were also indicator of increasing the rancidity of the wingko food as an increasing FFA content. However, sixth day after treatments, FFA content on control of wingko food was drastically increased more than 60% compare with wingko under different packaging treatments, although surface condition was tend to be dried, this indicate that rancidity condition and change in the odor of the wingko food were occurred.

Wingko food without packaging could be easily affected with aerial condition which have high oxygen concentration as a source of oxidation process with high temperature and high humidity in the tropical environment. Then, wingko food without packaging was quickly to be rancid, short shelf-life and quickly quality deterioration. All vacuum packaging treatments could be protected wingko food form environmental influences such as exposure to oxygen gases and moisture for external factor and
free fatty acid content of wingko was still stable and not affected the odor and rancidity through the lower concentration of oxygen inside packaging, it was similar with [7] [8] and [12]. Furthermore, polyethylene terephthalate is a good barrier to gases (oxygen and carbon dioxide) and moisture and it also has good resistance to heat, mineral oils, solvents, and acids [15].

**Figure 4.** Free fatty acid content of wingko product under different treatments for several days packaging treatments; K is a control of wingko without any treatments; P1 is single wingko food using vacuum plastic packaging with thickness 75 micron; P2 is six wingko food using vacuum plastics packaging with thickness 75 micron; P3 is twelve wingko food using plastic vacuum packaging with thickness 80 micron. Data was average from 3 wingko food with double replication measure.

Surface hardness of wingko food under different treatments of packaging was shown in the figure 5 below. Surface hardness of wingko food without packaging treatments was increased gradually and it will be dried and harder. This condition could be caused through quick interaction of the wingko food with aerial tropical environment and decreasing water content, then it will be quickly not to be consumed and have short shelf-life. Just after packaging treatments were applied to the wingko food, surface hardness of wingko food could depressed not to be harder quickly compare without packaging treatments or control, although surface hardness of wingko food gradually increase and wingko food tend to be harder than before or normal condition, similar condition with [6][11]. There were not significant different between the packaging treatments. Vacuum packaging using polyethylene plastics could be protected the wingko food from aerial outside environment [15], which it directly affected the surface hardness and dried of products without vacuum packaging treatments.

Value of yeast and mould that indicator of growth of microorganism was shown in the table 1 above. All packaging treatments with vacuum packaging can be protected the wingko food from yeast and mould until 7th days storage conditions and microorganism could be depressed. On the other hand, wingko food without packaging treatments or control was detected the yeast and mould value at the 5th days after storage, this indicate that vacuum packaging could be protected the wingko food and also depressed microorganism growth. Vacuum packaging that have low concentration of oxygen can inhibit microorganism such as yeast and mould that will growth inside packaging, this condition can be supposed through the function of the packaging treatments [6] [7][12] [15].

Wingko food with the different packaging treatments visually show for 0, 4th and 7th days in the figure 6. Normal condition of wingko food was shown in the 0 day, but situation at 4th day of the storage was changed in the several parameters. Surface hardness of wingko will tend to be oily and harder in the all packaging treatments and it will be dried and harder in the surface of the control. Aroma with small rancid and mould was detected in the control, however all packaging treatments was still normal condition except for oily of the surface wingko food tend to be harder than normal surface hardness. At 7th days storage, wingko food condition tend to be worse especially in control, with surface hardness to be harder and dried, color change, rancidity aroma and many moulds. However, all packaging vacuum
treatments were still good condition, although only in surface of the products was oily and watery and surface tend to be harder than normal condition. Vacuum packaging treatments could be protected wingko food under different amount of wingko and amount of wingko in one packaging treatments were have a similar result, it can be protected the wingko food from any unfavourable effects of quality deterioration which will affected the quality and shelf-life of the wingko food. Vacuum food packaging can retard product deterioration, retain the beneficial effects of processing, extend shelf-life, and maintain or increase the quality and safety of food [8][15]

Figure 5. Surface hardness of wingko product under different treatments for several days packaging treatments; K is a control of wingko without any treatments; P1 is single wingko food using vacuum plastic packaging with thickness 75 micron; P2 is six wingko food using vacuum plastics packaging with thickness 75 micron; P3 is twelve wingko food using plastic vacuum packaging with thickness 80 micron. Data was average from 3 wingko food with double replication measure.

Table 1. Value of yeast and mould test using Potato Dextrose Agar (PDA) media product under different treatments for several days packaging treatments; K is a control of wingko without any treatments; P1 is single wingko food using vacuum plastic packaging with thickness 75 micron; P2 is six wingko food using vacuum plastics packaging with thickness 75 micron; P3 is twelve wingko food using plastic vacuum packaging with thickness 80 micron. Data was average from 3 wingko food with double replication measure. Maximal standard number for yeast and mould on wingko was 1 x 10³ colony/gram from SNI 01-4311-1996.

| Days of Treatments | Value of Yeast and Mould |
|--------------------|--------------------------|
|                    | K  | P1  | P2  | P3  |
| 0                  | <1 x 10³ | <1 x 10³ | <1 x 10³ | <1 x 10³ |
| 1                  | <1 x 10³ | <1 x 10³ | <1 x 10³ | <1 x 10³ |
| 2                  | <1 x 10² | <1 x 10² | <1 x 10² | <1 x 10² |
| 3                  | <1 x 10³ | <1 x 10³ | <1 x 10³ | <1 x 10³ |
| 4                  | <1 x 10² | <1 x 10² | <1 x 10² | <1 x 10² |
| 5                  | 150,83 x 10³ | <1 x 10³ | <1 x 10³ | <1 x 10³ |
| 6                  | -- | <1 x 10³ | <1 x 10³ | <1 x 10³ |
| 7                  | -- | <1 x 10³ | <1 x 10³ | <1 x 10³ |
| Visual Day | K | (P1) | (P2) | (P3) |
|------------|---|------|------|------|
| Day-0 | ![Image](https://example.com/image1.png) | ![Image](https://example.com/image2.png) | ![Image](https://example.com/image3.png) | ![Image](https://example.com/image4.png) |
| **T = 29.8°C** | **RH = 69%** | **Surface = normal** | **Surface = normal** | **Surface = normal** | **Surface = normal** |
| **Color = normal** | **Color = normal** | **Color = normal** | **Color = normal** | **Color = normal** |
| **Odor = normal** | **Odor = normal** | **Odor = normal** | **Odor = normal** | **Odor = normal** |
| **Mould = no** | **Mould = no** | **Mould = no** | **Mould = no** | **Mould = no** |
| **Hardness = normal** | **Hardness = normal** | **Hardness = normal** | **Hardness = normal** | **Hardness = normal** |
| **Day 4th** | ![Image](https://example.com/image5.png) | ![Image](https://example.com/image6.png) | ![Image](https://example.com/image7.png) | ![Image](https://example.com/image8.png) |
| **T = 28.5°C** | **RH = 74%** | **Surface = dried (++)** | **Surface = oily (++)** | **Surface = oily (++)** | **Surface = oily (++)** |
| **Color = change pale** | **Color = normal** | **Color = normal** | **Color = normal** | **Color = normal** |
| **Odor = yeast (++)** | **Odor = normal** | **Odor = normal** | **Odor = normal** | **Odor = normal** |
| **Mould = yes (++)** | **Mould = no** | **Mould = no** | **Mould = no** | **Mould = no** |
| **Hardness = harder (++)** | **Hardnes = harder (+)** | **Hardnes = harder (+)** | **Hardnes = harder (+)** | **Hardnes = harder (+)** |
| **Day 7th** | ![Image](https://example.com/image9.png) | ![Image](https://example.com/image10.png) | ![Image](https://example.com/image11.png) | ![Image](https://example.com/image12.png) |
| **T = 29.4°C** | **RH = 52%** | **Surface = dried (+++)** | **Surface = oily watery (+++)** | **Surface = oily watery (+++)** | **Surface = oily watery (+++)** |
| **Color = change pale** | **Color = normal** | **Color = normal** | **Color = normal** | **Color = normal** |
| **Odor = yeast (+++)** | **Odor = normal** | **Odor = normal** | **Odor = normal** | **Odor = normal** |
| **Mould = yes (++++)** | **Mould = no** | **Mould = no** | **Mould = no** | **Mould = no** |
| **Hardness =Harder(++++)** | **Hardnes = harder (+++)** | **Hardnes = harder (+++)** | **Hardnes = harder (+++)** | **Hardnes = harder (+++)** |

**Figure 6.** Visual organoleptic of wingko product under different treatments for day-0, day-4th and day 7th. Change in surface of the wingko, color, odor, mold, and hardness of surface was visually inspected. Room condition were also shown.
4. Conclusion
Vacuum packaging treatments have good impact on several quality of wingko food at tropical environment conditions, for protecting its water and moisture content, FFA content, surface hardness, slightly yeast and mould growth. Amount of wingko food inside vacuum packaging were not significantly affected the quality and shelf-life of the product for the vacuum packaging treatments.

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