Influence of drying method on chemical properties of dried cracker

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Abstract. In Indonesia, crackers are mostly consumed as a snacks or a food condiment. Effect of the drying method and the addition of flavour to the chemical properties of dried crackers were investigated in the present study. The sun drying method carried out for 12 hours, while the oven drying method carried out in various temperatures i.e. 50, 60 and 70°C, RH 88% until achieved a constant weight. The observed flavour variants were garlic, chilli and seaweed. The crackers were observed for their chemical properties including ash, protein, crude fat, carbohydrate and moisture content, subsequently. The result showed that the temperature of oven drying method were significantly affected to ash, crude fat and carbohydrate of dried cracker. The highest protein content was produced by crackers that dried using oven drying method at 70°C, while the highest water content was produced by crackers that dried using oven drying method at 50°C. Afterward, the flavour addition was significantly affected the crude fat content. The addition of seaweed flavour produces crackers with the lowest protein content. While, the addition of chilli flavour produces crackers with the highest carbohydrate and moisture content, but lower ash content. Information about chemical properties of crackers that dried using sun drying method was observed in the present study.

1. Introduction

Indonesia has many traditional street foods, popularly known as *kaki lima*, which adds crackers as condiments. The crackers, known as kerupuk, are mostly made from wheat flour, tapioca flour and seasoned with garlic, fish flavour or chilli followed by drying process process to obtain a low moisture content that make it crispy when it fried. However, different regions of Indonesia have different cracker specialities.

The home industry is producing crackers mostly using sun-drying for the drying process that may take up to 12 h. However it depends on weather and when the rainy season the sunshine is limited. Use the oven method as an alternative during such season is particularly important.

Earlier studies reported the effect of drying temperature on the quality of food product. The drying temperature of 60 and 70°C had significant effect to chemical, sensory and microbiological quality of dried bananas [1]. The drying temperature 40 – 60 °C had significant effect to the taste of rice [2]. Further, the hot air drying at 50 – 70 °C and sun drying were known to affect the quality of pomegranate fruit leather [3]. Therefore, in this present study is used temperature of 50, 60 and 70 °C for the drying process of crackers. Sun drying method is the most widely used in the world even for industrial applications despite known adverse impacts. Accordingly, this study also investigated sun drying of crackers by considering traditional production methods by home industry and cracker samples were efficiently dried even if it took longer time. However, there is only a few information
that reported about the effects of drying method and temperature on the chemical properties of traditional Indonesian crackers. Therefore, this study aimed to investigate the effect of the drying method and the addition of flavour to the chemical properties of dried crackers.

2. Methods

2.1. Drying procedure

The crackers (garlic, chilli and seaweed) with average size of 7.5 × 2.6 × 0.2 cm (length × width × thick) were produced by Arga Pyramida home industry in Bandung district, Gunungkidul. The concentration of chilli powder and seaweed powder that added to the crackers dough during stirring process was 4% and 5%, respectively. Then, the crackers dough were placed in the tray for drying process. The sun drying was conducted from 8 to 2 o’clock a.m. during two days (12 h). Meanwhile, the oven drying was conducted in Memmert oven U.30 at temperature of 50, 60 and 70 °C and RH 88% to constant weight.

2.2. Chemical properties analysis

Ash, protein, fat and carbohydrate of dried crackers were analyzed according to AOAC [4]. The micro-kjeldahl method was used for determining crude protein. For crude protein analysis, Sample of 0.51 g was mixed with SeO₂ powder, K₂SO₄, CuSO₄.5H₂O and concentrated H₂SO₄ in kjeldahl flask and heated in hot plate for 2 h. Then the mixture was diluted with water and was distilled for 10 min followed by titration with HCL 0.01 N and compared with the blank.

Crude fat was determined by soxhlet extraction. Sample of 2 g was putted in closed paper tube then dried in oven at 80 °C for 1 h. The dried sample was transferred in soxhlet instrument and extracted using n-hexane solvent for 6 h. The samples was distilled and dried in oven at 105 °C until reach a constant weight.

Thermogravimetry method was used for ash content analysis. Two grams sample was heated in muffle furnace at 550 °C. Dried samples was cooled in desiccator and weighed to constant. Carbohydrate and moisture content of dried cracker were measured by differences method and moisture analyzer AND MX-50 respectively.

2.3. Statistical analysis

CoStat version 6.400 (CoHort software, Monterey, CA, 93940, USA) was used for statistical analyses. The effect of drying temperature at oven method to chemical properties of dried cracker was observed using one way ANOVA where Y column is chemical properties and 1st factor is temperature. Furthermore, the general conclusion about effects of dried cracker flavours and drying temperature to chemical properties was studied using two way ANOVA where Y column is chemical properties, 1st factor is dried cracker flavours and 2nd factor is drying temperatures. Means test using Duncan’s with significance level 0.05.

2.4. Characterization of dried cracker

Scanning Electron Microscopy (SEM) of the surface sun drying dried crackers was observed using Hitachi SU 3500 with acceleration potential of 3.00 kV [5].

3. Results and discussions

3.1. Chemical properties of dried cracker at sun drying 12 h method

The traditional drying method of cracker using sun drying was commonly used by the home industry. Therefore the study about chemical properties of cracker after sun drying process informed the consumers about main component in cracker before frying. Chemical properties of dried cracker at sun drying 12 h method are presented in figure 1.

Most of the foodstuff consists of organic matter and water, remaining mineral elements or ash. The ash content of dried cracker is related by ash content of the constituent material and moisture content
of the product [6]. The crude fat content in dried cracker has a tendency of increasing after frying process because of cooking oil addition [7].

Moisture content is important parameter during drying process that is affect to appearance, texture and shelf life of food product. Figure 2 is the cracker photographs and SEM images of dried cracker surface. Flavour powder addition in cracker caused cracker’s inside became porous so the water easily to evaporate during drying process [8].

The drying process applied to reduce and control the moisture content of food product which is effect to the final quality of crackers after frying. The decreasing moisture content in food product also decreasing water activity to a level when the growth of microorganism, enzymatic reactions and other deteriorative reaction are inhibited in order to extend their shelf life [9]. Chemical reaction and enzymatic and/or non-enzymatic that may occur during the drying process of the food products may lead to significant changes in the chemical composition and affecting their original structure [10,11].

The hazardous chemical is often misused in food i.e. borax, formalin, rhodamin-B and metanil yellow [12]. The color contamination, borax content and metal contamination of dried garlic cracker at sun drying 12 h are presented in Table 1. Based on Indonesian National Standard of dried cracker (SNI 01-4307-1996), the maximum metal contamination for lead, copper, zinc, mercury are 2.00, 30.00, 40.00 and 0.03 mg/kg respectively [13].

![Figure 1. Chemical properties of dried cracker by sun drying 12 h method](image)

Table 1. Color, borax and metal contamination properties of dried garlic cracker

|                      | Sun drying 12 h method | Indonesian National Standard (SNI 01-4307-1996) |
|----------------------|------------------------|-----------------------------------------------|
| Rhodamin-B color     | Negative               | Negative                                      |
| Metanil yellow color | Negative               | Negative                                      |
| Borax contain        | Negative               | Negative                                      |
| **Metal contamination** |                       |                                               |
| Lead (Pb)            | 2.72 mg/kg             | 2.00 mg/kg                                    |
| Cadmium (Cd)         | <0.02 mg/kg            |                                               |
| Copper (Cu)          | 1.28 mg/kg             | 30.00 mg/kg                                   |
| Zinc (Zn)            | 27.79 mg/kg            | 40.00 mg/kg                                   |
| Mercury (Hg)         | 8.66 µg/kg             | 0.03 mg/kg                                    |
Figure 2. Dried crackers photograph and SEM images of the surface morphological structure by sun drying 12 h method:
(a) garlic flavour (b) chilli flavour (c) seaweed flavour

3.2. Chemical properties of dried cracker by oven method

The oven method by convection drying system can control the temperature and air dryer speed that is related to the ability of a food material to maintain its final quality [14,15]. Moreover, the oven method is more hygienic than the sun drying method. Chemical properties of dried cracker by oven method are presented in Table 2.

Protein content of garlic dried cracker at 70 °C was significantly increased while in chilli dried cracker was significantly decreased. Ash content of garlic dried cracker significantly varied among different temperatures but showed no significant variation in chilli and seaweed dried cracker. The increasing level of temperatures has a tendency of decreasing the crude fat in chilli and seaweed dried cracker.
cracker. The lower crude fat of garlic dried cracker at 60 °C. Carbohydrate content of garlic, chilli and seaweed dried crackers at drying temperature 70 °C were significantly increased. The lower moisture content of garlic and seaweed dried crackers was at drying temperature 70 °C. However in chilli dried cracker, the lower moisture content was at 60 °C.

Table 2. Chemical properties of dried cracker by oven method

| Chemical properties (% wb) | Temp (°C) | garlic | chilli | seaweed |
|---------------------------|-----------|--------|--------|---------|
|                           | 50        | 7.09±0.32<sup>b</sup> | 7.40±0.05<sup>a</sup> | 6.94±0.19<sup>b</sup> |
|                           | 60        | 7.19±0.11<sup>b</sup> | 7.48±0.02<sup>a</sup> | 7.18±0.09<sup>ab</sup> |
|                           | 70        | 7.98±0.35<sup>a</sup> | 7.31±0.04<sup>b</sup> | 7.28±0.09<sup>a</sup> |
| Ash                       | 50        | 4.35±0.02<sup>b</sup> | 3.85±0.05<sup>a</sup> | 4.12±0.01<sup>a</sup> |
|                           | 60        | 4.77±0.11<sup>a</sup> | 3.81±0.03<sup>a</sup> | 4.12±0.11<sup>a</sup> |
|                           | 70        | 3.33±0.04<sup>c</sup> | 3.79±0.03<sup>a</sup> | 4.11±0.02<sup>a</sup> |
| Crude fat                 | 50        | 0.96±0.13<sup>a</sup> | 0.35±0.04<sup>a</sup> | 2.15±0.07<sup>a</sup> |
|                           | 60        | 0.45±0.13<sup>b</sup> | 0.25±0.02<sup>b</sup> | 1.24±0.11<sup>b</sup> |
|                           | 70        | 0.79±0.09<sup>c</sup> | 0.13±0.02<sup>c</sup> | 0.41±0.12<sup>c</sup> |
| Carbohydrate              | 50        | 86.53±0.36<sup>b</sup> | 86.60±043<sup>b</sup> | 85.49±0.21<sup>c</sup> |
|                           | 60        | 86.15±0.36<sup>b</sup> | 87.89±0.19<sup>a</sup> | 86.43±0.26<sup>b</sup> |
|                           | 70        | 87.31±0.31<sup>a</sup> | 87.34±0.18<sup>a</sup> | 87.64±0.26<sup>a</sup> |
| Moisture content          | 50        | 1.06±0.15<sup>b</sup> | 1.80±0.31<sup>a</sup> | 1.30±0.08<sup>a</sup> |
|                           | 60        | 1.45±0.21<sup>a</sup> | 0.57±0.20<sup>b</sup> | 1.02±0.22<sup>a</sup> |
|                           | 70        | 0.59±0.02<sup>c</sup> | 1.41±0.15<sup>a</sup> | 0.57±0.26<sup>b</sup> |

Values are as mean ± standard deviation. Different letters in the same row indicate significant differences (p < 0.05)

4. Conclusions
The study about chemical properties of cracker after sun drying process informed the consumers about main component in cracker before frying. The color contamination, borax content and metal contamination of dried garlic cracker at sun drying 12 h safe for consumer, based on Indonesian National Standard of dried cracker. As additional information the oven method is more hygiene than the sun drying method. Ash content of garlic dried cracker significantly varied among different temperatures and protein content significantly increased at 70 °C. The increasing level of temperatures has a tendency of decreasing the crude fat in chilli and seaweed dried cracker. Carbohydrate content of garlic, chilli and seaweed dried crackers at drying temperature 70 °C were significantly increased. The difference moisture content in different temperature of oven drying method is influenced by addition of flavoured powder.

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