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Review Article

The quality of tinuktuk in the frozen temperature storage

Marini Damanik - *https://orcid.org/0000-0002-6898-2034*
Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, Medan 20221, Indonesia

Ida Duma Riris - *https://orcid.org/0000-0002-3480-7334*
Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, Medan 20221, Indonesia

Nora Susanti - *https://orcid.org/0000-0002-6511-9657*
Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, Medan 20221, Indonesia

Nurul Ramadhaniyah
Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, Medan 20221, Indonesia

Jihan Afstria Rinanda
Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, Medan 20221, Indonesia

Corresponding authors: Marini Damanik (E-mail: marini@unimed.ac.id)

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ABSTRACT

Tinuktuk is considered nutritious and able to boost immunity. A local product based on natural resources and spices in Indonesia. The different concentrations of the main ingredients used in the production of tinuktuk produce good quality and nutrition for safe, healthy, and nutritious consumption. So far, there is no optimum composition of tinuktuk and also quality analysis during the storage period in the frozen temperature of tinuktuk, so this research is necessary. In this research, the roasting method is used for the drying process of making tinuktuk. The roasting process is one of the isothermal drying processes. The purpose of this study was to determine the quality characteristics of tinuktuk during storage at -10°C for 56 days which is analyzed every 7 days. Tinuktuk characteristic parameters include pH, moisture content, ash content, and microbial analysis. The results of the research that have been carried out are 30%: 70% and 40%: 60%, which have similarities with the results of the analysis of tinuktuk that has been marketed, namely the 30%: 70% ratio, wherein the 30%: 70% ratio the pH analysis decreases steadily from 6.3 to 5.9. Ash content analysis resulted in a stable decrease from 7% to 5%. Microbial analysis with ALT testing resulted in stable data during storage at 2.5 x 102 colonies/g. Antioxidant analysis of 30%:70% ratio resulted in antioxidant IC_{50} data of 93, 4 ppm to 183.6 ppm.

Introduction

Indonesia is the largest archipelago with very high biodiversity, especially flora diversity. In this regard, Indonesia is also considered a producer of spices. This marked the arrival of European countries to Indonesia. Various plants or spices commonly used for seasoning in traditional medicine have been used since ancient times. This traditional medicine has been proven to help overcome health problems for generations (Supriani, 2019).

Traditional medicine is a system of medicine that is considered a cultural system. Conventional medicine is practiced traditionally, and the materials and processing methods remain traditional. Traditional medicine that has been used for generations is not only used to treat certain diseases but also to restore maternal health after childbirth (Simanjuntak, 2017). One of the less documented local wisdom in the field of medicine is the local wisdom of the Batak community in the Simalungun Batak tribe (Fig-1).

The Karo Batak tribe and the Simalungun Batak tribe still use traditional medicinal herbs (Silalahi, 2019). This situation opens up trade in medicinal plants and traditional medicinal ingredients in North Sumatra. Since the time of the ancestors of the Simalungun Batak tribe, tinuktuk has been very popular as a spice and herbal medicine that is beneficial for its consumption and quite popular. Tinuktuk itself comes from the word "ti" which means "yang", while the word "nuktuk" means "mashed", so the meaning of the word Tinuktuk is mashed. Tinuktuk itself has been around for a long time and is believed to have very good properties for the health of the body (Damanik et al., 2023).

According to (Haryana et al., 2022) The health benefits of tinuktuk include maintaining a healthy body, especially for people who often work hard, warming the body, and helping sleep well. In addition, the community, especially mothers who have just given birth, is accustomed to receiving chili-based snacks. In every region where Simalungun's people lives, this chili is processed differently and has several different names. The main ingredients of making tinuktuk are herbs and spices such as red ginger and black pepper, red ginger (*Zingiber officinale* Roscoe) is one of the discoveries from the *Zingiberaceae*

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family which plays an important role in various aspects of Indonesian society (Pakpahan, 2015). Herbs and spices have been used for a long time as coloring or preservative agents by adding to the content of foods, and at the same time to increase the nutritional value of foods (Karakol & Kapi, 2021).

Fig-1. Tinuktuk.

Red ginger is well known in Asia for its medicinal uses. Ginger extract is known to have antioxidant, anticancer, antimicrobial, and rheumatic effects. The ginger extract contains oleoresin and volatile oil which has a yellow, oily, pungent aroma. Excellent concentration of bioactive compounds, including phenolic compounds (catechin, epicatechin, quercetin), pungent non-volatile compounds contains (gingerols, paradols, shogaols, and zingerones) that play a role in its antioxidant activity, and terpenes (Yu et al., 2022). Gingerol and 6-gingerol are the main components of oleoresin that are sensitive to heat, light, and oxygen. Gingerol and shogaol are the sources of ginger's spicy and pungent flavor (Sholikhati et al., 2021).

Ginger (*Zingiber officinale* Roscoe) consumption has been associated with several health benefits attributed to its excellent concentration of bioactive compounds, including phenolic compounds (catechin, epicatechin, quercetin), pungent non-volatile compounds (gingerols, paradols, shogaols, and zingerones), and terpenes (Yu et al., 2022). In addition, the phytochemical composition may also contribute to the flavor characteristics of beverages processed using ginger, such as a refreshing citrus aroma and a sweet and slightly spicy flavor (Pujiati et al., 2021).

In addition to red ginger, it is used as an ingredient in traditional medicine preparations. Black pepper is a medicinal plant that grows in many tropical countries including Indonesia and is often used as a spice. Black pepper is widely used in the treatment of diarrhea, anti-inflammatory, hepatoprotectant, and stomach heartburn. The main content of black pepper is piperine (Febrianty et al., 2018). The chemical composition of pepper can mainly be divided into three groups. a) compounds that contribute to pungency (spicy). b) compounds that produce a distinctive aroma. c) Compounding compounds of the main component (starch). The aroma of pepper comes from the volatile oils contained in the fruit, and its alkaloid content, especially piperine, is important for the pungent flavor. Pepper extract in the form of oleoresin which also contains phenolic compounds is also commercially available. Starch contributes to the cooking and nutritional value of black pepper. Crop quality is the most important criterion when growing spices, and pepper is no exception. The quality of pepper is mainly determined by the amount of piperine, volatile oil, and oleoresin (Milenković & Stanojević, 2021).

During storage, the resulting tinuktuk product is prone to microbiological quality deterioration, which is characterized by microbial growth in the form of bacteria, and sensory damage that occurs, namely changes in aroma or odor, while chemically the onset of acid in tinuktuk. The decline in the quality of tinuktuk causes product rejection by consumers and a decrease in the shelf life of tinuktuk. Tinuktuk is a highly nutritious and immunomodulatory local product based on natural resources of spices and herbs in Indonesia. With different concentrations of the main ingredients, making tinuktuk by roasting can produce good quality and nutrition so that it is safe, healthy, and nutritious for consumption (Damanik et al., 2023).

This study aims to provide an overview of the comparison between red ginger and black pepper using the roasting method during storage in the manufacture of tinuktuk. The comparison or concentration used in this study is 30:70% and 40:60% where the concentration is the result of a preliminary study. Several concentrations of 100:0%, 70:30%, 60:40%, 50:50%, 40:60%, 30:70%, 0:100%, and 0:0% from the previous study have been analysed. From the results obtained from previous studied, the concentrations of 30:70% and 40:60% have good quality, so this study took samples of these concentrations that had been optimized and tested more deeply so that of the 2 concentrations it could be seen which one was superior in chemical properties. Tests include pH analysis, water content, ash content, microbial analysis, and antioxidant analysis carried out during storage at frozen temperatures.

Methods

Tools and Materials

The tools used include dry material grinder, electric stove, wet material grinder, frying pan, electric scale, spoon, plastic container, knife, cutting board, pH meter, UV-Vis Spectrophotometry (Spectroquant pharo-300) (Merck KGaA, Darmstadt, Germany), beaker, oven, desiccator, porcelain cup, measuring cup, petri dish, furnace, tongs, refrigerator and analytical balance.

Materials are red ginger (*Zingiber officinale* Roscoe), black pepper (*Piper Ningrum*), andaliman (*Zanthoxylum acanthopodium* DC), aromatic ginger (*Kaempferia galanga*), cikala acid, shallots (*Allium cepa* L.), garlic (*Allium sativum*), candlenut (*Aleurites moluccanus*) and Himalayan salt. Chemicals were Aquadest, methanol (p.a) (Merck; Darmstadt, Germany), Plate Count Agar (PCA) (Merck; Darmstadt, Germany), Buffered Peptone Water (Merck; Darmstadt, Germany), 96% Ethanol (Merck, Darmstadt, Germany), Vitamin C and DPPH (Sigma Aldrich; St. Louis, MO).

Test the Chemical Characteristics of Tinuktuk

Analysis of pH Levels

A total of 5 g of tinuktuk sample storage at -10°C for 56 days which is analyzed every 7 days was used to determine pH with a pH meter. The pH meter was first calibrated using a buffer with pH values of 4 and 7. The pH meter was placed in the sample solution after the electrode was cleaned and rinsed with distilled water. By reading the scale to determine the pH level (AOAC, 2005).

Moisture Content Analysis

Using an analytical balance to weigh the sterile petri dish and calculate the empty weight of the dish. Tinuktuk samples were weighed into Petri dishes with a total weight of 10 g. After drying for 3 hours at 105°C in the oven, the tinuktuk samples were cooled in a desiccator before weighing. It was then put back into the oven for an additional hour, allowed to cool in a desiccator, and weighed together with the dried sample in the petri dish until a stable weight was reached (AOAC, 2005).

Ash Content Analysis

Ash content was measured by the dry ignition method using a furnace. After drying the porcelain cup in an oven at 600°C for 1 hour, it was cooled in a desiccator and weighed. A total of 2 grams of Tinuktuk sample was weighed into a porcelain cup. Let stand again at 600°C for 2 hours until white ash is formed, cool in a desiccator and porcelain cup, and sample until constant weight (AOAC, 2005).

Microbial Analysis

Total Plate Count Method (TPC) testing was carried out to determine the level of microbial contamination in Tinuktuk products. Tinuktuk was tested at dilutions of 10-1, 10-2, 10-3, 10-4, 10-5, 10-6. Weighed 25 grams of Tinuktuk sample into a 250 mL beaker and added 225 mL buffered peptone water (BPW) as a diluent until the limit mark. To get a dilution of 10-1, 9 mL of BPW was inserted into the test tube, plus 1 mL of sample solution, and then vortexed for 1 minute. And repeated until getting dilution 10-6. Entered into a sterile Petri dish sample as much as 1 mL at each dilution. Poured PCA media as much as 15-20 mL into Petri dishes that already contain each sample. After solidifying the cup is closed with adhesive film and then incubated at 37 °C for 48 hours in an inverted position. Observations were made to see the number of colonies for 2 x 24 hours in each dilution (BSN, 2008).

Antioxidant Activity

Preparation of the DPPH solution is by weighing DPPH as much as 5 mg and then dissolving it with 25 ml of methanol in a volumetric flask to obtain a concentration of 200 ppm. The parent sample solution was made 1000 ppm by dissolving 10 mg of extract in 10 mL of methanol p.a. Furthermore, the parent solution was made variations of 100; 150; 200; 250; and 300 ppm then the volume was sufficient to 5 mL, and then vortexed and then incubated for 30 minutes in an incubator and then read the absorbance by using a UV-Vis spectrophotometer at a wavelength of 517 nm (Brand-Williams, 1995).

Ascorbic acid (Vitamin C) was weighed as much as 10 mg then dissolved using methanol p.a while homogenized, and put in a 10 mL volumetric flask, sufficient volume to the limit mark. A concentration of 1000 ppm was obtained. Then vortexed and incubated for 30 minutes in an incubator after which the absorbance was read using a UV-Vis spectrophotometer at a wavelength of 517 nm.

Results and Discussion

Effect of pH

A storage temperature of -10°C will decrease the pH value during storage. When stored at higher temperatures, the pH drops faster when stored at lower temperatures, the pH drops slower. This is because lower temperatures prevent a decrease in pH during storage while higher temperatures cause a faster decrease in pH (Pangestu et al., 2021). The data in the figure above explains the pH value of the 30:70% concentration comparison, at storage 0, 7, and 14 days the pH was 6.3, at storage 21, and 28 days the pH value was 6.1, at storage 35, 42 days the pH was 6, and the lowest pH value at storage 49 and 56 days was 5, 9. While at a concentration of 40: 60% the pH value of 0, at 7 days of storage was 6.2, at 14, and 21 days of storage the pH was 6.1, at 28 days of storage the pH was 6, at 35 days of storage the pH was 5.9, and the lowest pH value at 42.49 and 56 days storage was 5.8 (Fig-2).

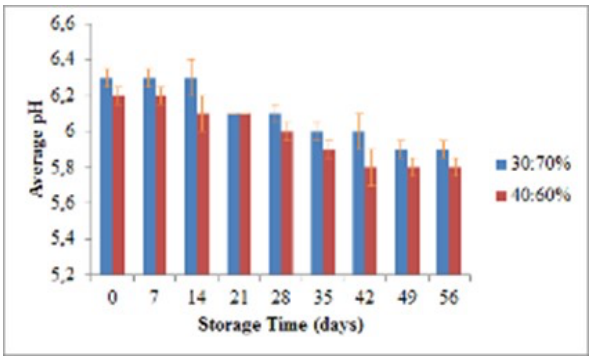

Fig-2. The pH level of tinuktuk in 0 – 56 days.

It is clear from the Fig-2, that the 30:70% ratio of pH during storage decreased more slowly than the 40:60% ratio. That the pH decreases more slowly during storage (Purnomo & Adiono, 1987). Microbial activity that consumes nutrients as a by-product of energy requirements is what causes the pH to drop during storage. pH drops as a result of the conversion of some of these nutrients into organic acids. When stored, sodium benzoate is converted to benzoic acid, which along with the activity of lactic acid bacteria (Sulistyaningrum & Darudryo, 2018).

Effect of Moisture Content

The average value for moisture content treatments is around 55% to 57% in the Fig-3. A maximum moisture content of 70% is an acceptable quality level for hot sauce as stated in SNI 01-2976-2006. The moisture content of Tinuktuk products will increase when stored at certain temperatures and times. According to (Nursari et al., 2016), an increase in moisture content also increases water activity, which can encourage microbial development and damage the product. Water serves as a medium for microbial growth, therefore the moisture content of food ingredients must always be considered (Herawati, 2008).

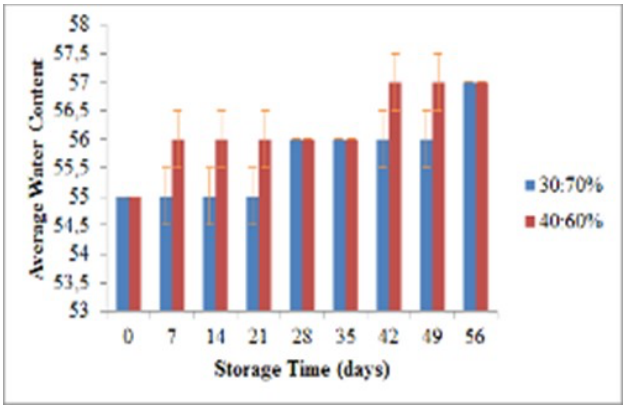

Fig-3. Tinuktuk water content in 0 – 56 days.

Changes in product moisture content are one of the factors identified as having a major impact on food spoilage. The temperature and humidity of the storage room can have an impact on changes in the moisture content of chili sauce. The moisture content of food can also be changed by microbial growth activities that produce H_2O or water vapor as metabolites (Sopandi, 2014).

Effect of Ash Content

Ash is an inorganic substance produced during the combustion process of foodstuffs. The ash content of food ingredients shows the mineral content of processed products. Ash is related to minerals in foodstuffs. Minerals contained in the material consist of two types of salts, namely organic salts and inorganic salts (Sudarmadji, 2010). These mineral elements are also called inorganic substances or ash (Winarno, 2008). According to the quality standard of SNI 01-3709-1995, the maximum ash content in crumb spices is 7% (Shadri et al., 2018).

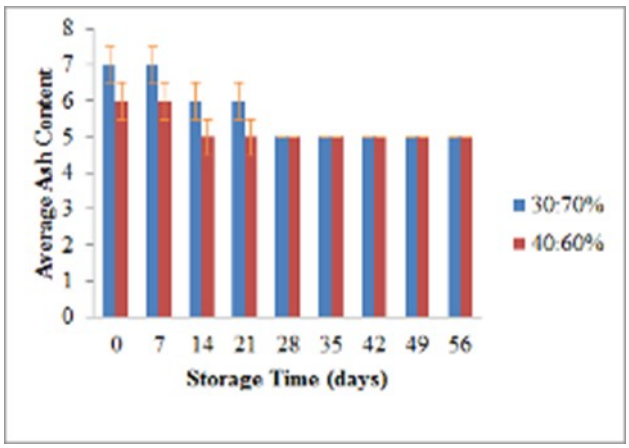

Fig-4. Tinuktuk ash content in 0 – 56 days.

Fig-4 shows that the ash content of tinuktuk decreased during storage, with concentration (30:70%) at storage 0,7 days the ash content was 7%, at storage 14, 21 the ash content was 6% and the lowest ash content at storage 28, 35, 42, 49 and 56 was 5%. For the concentration (40:60%) at 0,7 days storage, the ash content was 6%, and the lowest ash content at storage times of 14, 21, 28, 35, 42, 49, and 56 was 5%. Minerals contained in Tinuktuk are lost during the long storage process at cold temperatures. Thus, from the beginning to the length of storage the ash content of tinuktuk did not exceed the SNI threshold on the ash content of spices.

Microbial Analysis

The total plate count is an indicator of the number of microbes, especially spoilage microbes, present in the product. SNI 01-2976-2006 and 01-3546-2004 for chili and tomato sauce require a maximum ALT value of 1.0 x 104 colonies/g. Microbial growth can only be inhibited by low-temperature storage, so the product is still within SNI specifications. Garlic contains bioactive substances such as antibacterial and sulfur-containing volatile allicin compounds. The antibacterial effect of garlic can combat both Gram-negative and Gram-positive bacteria. The addition of garlic is used for the decontamination of bacteria such as *Staphylococcus aureus*, *Escherichia coli*, Salmonella typhimurium, and *Pseudomonas aeruginosa* to maintain the quality of food ingredients and improve food safety (Prihandani et al., 2015).

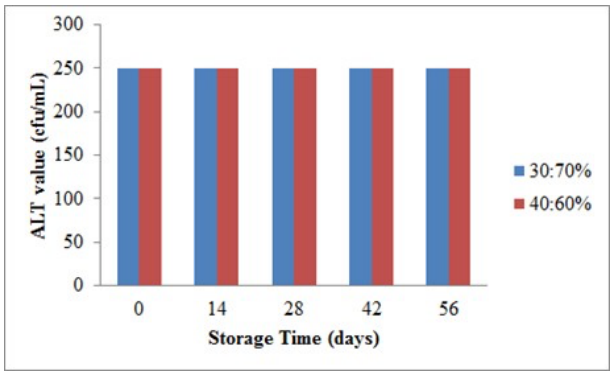

Fig-5. Tinuktuk microbial analysis in 0 – 56 days

In addition to garlic, the ethanol content of 60% concentration in shallot bulbs shows a good inhibitory effect against Staphylococcus aureus. This is because shallots contain allicin, allin, pectin, and flavonoids as antibacterials (Mardhiyyah & Ningsih, 2021). Salt solutions cause osmotic processes in microbial cells, causing protoplasmolysis and resulting in bacterial death. NaCl has an antibacterial effect against microbes and harmful microbes, and when combined with acids such as vinegar and citric acid, it is more potent against microbes (Ratnasari et al., 2016). In this study, there was no tendency to increase ALT during the 0-56 days storage period when stored at low temperatures. The ALT value in the sample was 2.5 x 102 colonies/g (Fig-5). Therefore, Tinuktuk products are safe to consume even after two months of storage. This is because cold storage can prevent food spoilage, especially physiological, enzymatic, and microbiological damage (Asiah et al., 2018).

Antioxidant Analysis

Food antioxidants are natural substances that are usually present in fresh, unprocessed foods. Antioxidants can extend the life of food products, by protecting them from damage caused by oxidation as well as their use as food additives (Pruteanu et al., 2023). Most foods are warmed before eating. Their content drops after cooking due to chemical and physical damage. According to (Aisyah et al., 2014), the limitation of antioxidant chemicals is that they deteriorate quickly due to exposure to oxygen, light, heat, and dryness. Due to heating during production, the antioxidant activity of tinuktuk was examined (Fig-6).

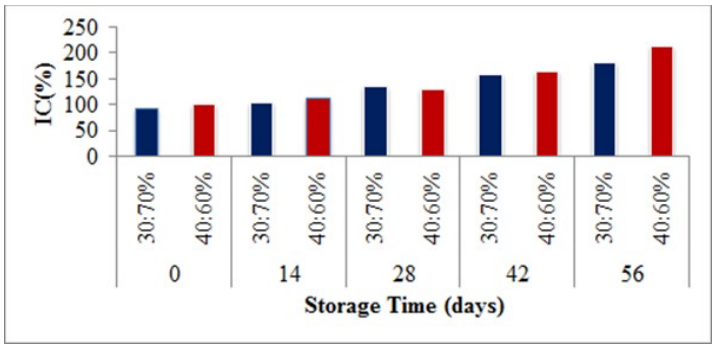

Fig-6. Relationship between antioxidants added in the ratio of 30%: 70%, 40%: 60%, vitamin C to storage time for 0, 14, 28, 42, and 56 days using the DPPH method.

Based on the calculation of antioxidant activity analysis of tinuktuk, the value of 50% inhibitor concentration (IC_{50}) obtained at a percentage of 30: 70% during storage 93.4 ppm, 107.3 ppm, 137.5 ppm, 160.2 ppm, 183.6 ppm. At 40:60% during storage 104.6 ppm, 115.5 ppm, 132.8 ppm, 166.9 ppm, 216.7 ppm. The comparison material in antioxidant testing is ascorbic acid (Vit C) using a concentration of 2, 4, 6, 8, and 10 ppm. IC_{50} value on Vit C during storage amounted to 9.28 ppm, 10.37 ppm, 10.61 ppm, 10.93 ppm, and 12.72 ppm. According to (Naibaho et al., 2020), weak intensity is present if the IC_{50} value is greater than 500 ppm. According to (Khairunnisa et al., 2018), antioxidant activity decreases with increasing IC_{50} value. According to (Agnesty, 2017), the antioxidant strength level of a compound is classified as very strong if the IC_{50} value is less than 50 ppm, strong if the IC_{50} value is between 50 and 100 ppm, moderate if the IC_{50} value is between 100 and 500 ppm, and weak if the IC_{50} value is greater than 500 ppm. As a result of heating the black pepper, andaliman, and candlenut to make tinuktuk, the antioxidant content of the ingredients will be reduced resulting in low antioxidant activity of the tinuktuk product also due to the length of storage.

Conclusion

The conclusion that can be drawn from the research that has been done between the ratio of red ginger and black pepper at frozen temperatures that still have good quality for 2 months of storage in terms of chemical analysis characteristics is the ratio of 30: 70% with a pH value of 5.9, a moisture content value of 57%, an ash content value of 5%, the number of colonies of 2.5 x 102 colonies/g, an IC_{50} value of 183.6 ppm.

Conflict of Interests

The author(s) declares that there is no conflict of interest in this research and manuscript.

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References

Agnesty, D. (2017). Pengaruh perbandingan andaliman dengan batang kecombrang dan suhu pengeringan terhadap mutu bubuk sambal andaliman. *Skripsi*. Jurusan Teknologi Pangan, Fakutas Pertanian, Universitas Sumatera Utara.

Aisyah, Y., Rasdiansyah, R., & Muhaimin, M. (2014). Pengaruh pemanasan terhadap aktivitas antioksidan pada beberapa jenis sayuran. *Jurnal Teknologi dan Industri Pertanian Indonesia*, 6(2), 28–32. https://doi.org/10.17969/jtipi.v6i2.2063

AOAC. (2005). *Official method of analysis*. 18th Edition, Association of Officiating Analytical Chemists, Washington DC, Method 935.14 and 992.24.

Asiah, N., Cempaka, L., & David, W. (2018). *Panduan praktis pendugaan umur simpan produk pangan*. Jakarta Selatan: UB Press.

Brand-Williams, W., Cuvelier, M. E., & Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT - Food Science and Technology*, 28(1), 25–30. https://doi.org/10.1016/s0023-6438(95)80008-5

BSN. (2008). Metode pengujian cemaran mikroba dalam daging, telur dan susu, serta hasil olahannya. SNI, 2897, 2008.

Damanik, M., Rosmiati, R., Permatasari, T., Aulia Surbakti, T., & Ayuni, S. (2023). Ash, protein and salinity analysis of integrated formulation of herbs and spices in typical Simalungun "Tinuktuk" North Sumatera-Indonesia. *International Journal of Health and Pharmaceutical (IJHP)*, 3(3), 545–549. https://doi.org/10.51601/ijhp.v3i3.177

Febriyanti, A. P., Iswarin, S. J., & Susanti, S. (2018). Penetapan kadar piperin dalam ekstrak buah lada hitam (Piper nigrum Linn.) menggunakan liquid chromatography tandem mass spectrometry (LC–MS/MS). *Jurnal Ilmiah Farmasi Farmasyifa,* 1(2), 69–79. https://doi.org/10.29313/jiff.v1i2.3160

Haryana, N. R., Permatasari, T., Damanik, M., Pratiwi, C., & Bahri, H. (2022). Peningkatan pengetahuan gizi dan higiene sanitasi pengolahan produk pada usaha tambar tinuktuk khas Simalungun di kota Pematangsiantar. *Abdimas Unwahas*, 7(2). https://doi.org/10.31942/abd.v7i2.7506

Herawati, H. (2008). Penentuan umur simpan pada produk pangan. *Jurnal Litbang Pertanian*, 27(4), 124-130.

Karakol, P., & Kapi, E. (2021). *Use of selected antioxidant-rich spices and herbs in foods*. Antioxidants - Benefits, Sources, Mechanisms of Action. https://doi.org/10.5772/intechopen.96136

Khairunnisa, K., Ridwansyah, R., & Rusmarilin, H. (2018). Pengaruh perbandingan jumlah cabai merah dengan andaliman terhadap mutu sambal andaliman dan penentuan umur simpan. *Jurnal Rekayasa Pangan dan Pertanian*, 6(4), 724–733.

Mardhiyyah, Y. S., & Ningsih, I. (2021). Masa simpan aneka sambal dari bahan nabati menggunakan metode accelerated shelf life testing: kajian literatur. *Agrointek*, 15(2), 459–468. https://doi.org/10.21107/agrointek.v15i2.9290

Milenković, A. N., & Stanojević, L. P. (2021). Black pepper: Chemical composition and biological activities. *Advanced Technologies*, 10(2), 40-50. https://doi.org/10.5937/savteh2102040M

Naibaho, N. M., Damanik, N. S., & Syauqi, A. (2020). Profil organoleptik sambal segar andaliman (Zanthoxylum acanthopodium DC) dan batang kecombrang (Etlingera elatior) muda. *Journal of Tropical Agri Food*, 2(1), 1. https://doi.org/10.35941/jtaf.2.1.2020.3842.1-7

Nursari, N., Karimuna, La., & Tamrin, T. (2016). Effect of pH and pasteurization temperature on chemical characteristics, organoleptic and shelf life of sambal. *Jurnal Sains dan Teknologi Pangan*, 1 (2), 151-158.

Pakpahan, T. L. (2015). Manfaat jahe merah (zingiber officinale roscoe) terhadap kadar asam urat. *Jurnal Agromedicine*, 2(4), 530-535.

Pangestu, A. D., Kurniawan, K., & Supriyadi, S. (2021). Pengaruh variasi suhu dan lama penyimpanan terhadap viabilitas bakteri asam laktat (BAL) dan nilai pH yoghurt. *Borneo Journal of Medical Laboratory Technology*, 3(2), 231–236. https://doi.org/10.33084/bjmlt.v3i2.2169

Pujiati, Sulistyarsi, A., & Prafitasari, N. F. (2022). The quality test of fermented ginger drink (Ginger Ale) produced from various types of Indonesian ginger. *Advances in Social Science, Education and Humanities Research*, 603, pp. 152-159. https://doi.org/10.2991/assehr.k.220103.023

Prihandani, S.S., Poeloengan, M., Noor, S.M., & Andriani, A. (2015). Antibacterial activity test of garlic (Allium Sativum L.) powder against Staphylococcus aureus, Escherichia coli, Salmonella typhimurium and Pseudomonas aeruginosa for improving food safety. *Informatika Pertanian*, 24(1), 53-58. https://dx.doi.org/10.21082/ip.v24n1.2015.p53-58

Pruteanu, L. L., Bailey, D. S., Grădinaru, A. C., & Jäntschi, L. (2023). The biochemistry and effectiveness of antioxidants in food, fruits, and marine algae. *Antioxidants*, 12(4), 860. https://doi.org/10.3390/antiox12040860

Purnomo, H., & Adiono, A. (1987). *Ilmu pangan*. UI Press: Jakarta. https://onesearch.id/Record/IOS4680.JATIM000000000016366

Ratnasari, Z., Baehaki, A., & Supriadi, A. (2016). Penggunaan garam, sukrosa dan asam sitrat konsentrasi rendah untuk mempertahankan mutu fillet ikan GABUS (Channa striata). *Jurnal FishtecH*, 3(1), 8–14. https://doi.org/10.36706/fishtech.v3i1.3525

Silalahi, M. (2020). Ramuan obat tradisional sub-etnis Batak Karo yang diperjualbelikan di pasar Berastagi dan Kabanjahe Sumatera Utara. *Jurnal Ilmiah Kesehatan Keperawatan*, 15(2), 15. https://doi.org/10.26753/jikk.v15i2.293

Simanjuntak, H. A. (2017). Etnobotani tumbuhan obat di masyarakat ETNIS Simalungun Kabupaten Simalungun Provinsi Sumatera Utara. *BIOLINK (Jurnal Biologi Lingkungan Industri Kesehatan)*, 3(1), 75–80. https://doi.org/10.31289/biolink.v3i1.814

Shadri, S., Moulana, R., & Safriani, N. (2018). Kajian pembuatan bubuk serai dapur (Cymbopogon citratus) dengan kombinasi suhu dan lama pengeringan. *Jurnal Ilmiah Mahasiswa Pertanian*, 3(1), 371–380. https://doi.org/10.17969/jimfp.v3i1.6435

Sholikhati, A., Farikhah, L., & Ridwanto, M. (2021). Antioxidant effect in red ginger (Zingiber officinale var. rubrum) extract during the covid-19 Pandemic. *The International Conference on Public Health Proceeding*, 6(01), pp. 1157-1162. https://doi.org/10.26911/icphmedicine.fp.08.2021.09

Sopandi, T., & Wardah, A. (2014). *Mikrobiologi pangan*. Yogyakarta: Penerbit Andi.

Sudarmadji, S. (2010). *Analisa bahan makanan dan pertanian*. Yogyakarta: Liberty.

Sulistyaningrum, A., & Darudryo, D. (2019). Decreasing of cayenne pepper quality during storage in room temperature. *Jurnal Agronida*, 4(2). https://doi.org/10.30997/jag.v4i2.1566

Supriani, A. (2019). Peranan minuman dari ekstrak jahecang untuk meningkatkan kesehatan masyarakat. *Jurnal Sain Health*, 3(1), 30. https://doi.org/10.51804/jsh.v3i1.370.30-39

Winarno, F.G. (2008). *Kimia pangan dan gizi*. Jakarta: Gramedia Pustaka Media.

Yu, D., Zhang, X., Guo, S., Yan, H., Wang, J., Zhou, J., Yang, J., & Duan, J.-A. (2022). Headspace GC/MS and fast GC e-nose combined with chemometric analysis to identify the varieties and geographical origins of ginger (Zingiber officinale Roscoe). *Food Chemistry*, 396, 133672. https://doi.org/10.1016/j.foodchem.2022.133672