The Proceeding of 6th International Nutrition and Health Symposium

October, 2022

STUDY OF GROWOL COOKIES' SHELF-LIFE TIME BASED ON WATER CONTENT ANALYSIS

Desty Ervira Puspaningtyas[1*], Puspita Mardika Sari[2], Silvia Dewi Styaningrum[3], Adi Sucipto[4], Dhea Putri Ananda[5], Renata Deby Sintia[6]

[1*,2,3,5,6]Nutrition Program, Faculty of Health Sciences, Universitas Respati Yogyakarta, Yogyakarta; [4]Nursing Program, Faculty of Health Sciences, Universitas Respati Yogyakarta, Yogyakarta

*Corresponding author's email: desty_puspaningtyas@respati.ac.id

Abstract

Background: The addition of inulin to growol cookies can optimize the role of cookies as a diabetic snack. The growol cookies formula with low glycaemic index and glycaemic load has been successfully formulated. To meet commercial food standards, the growol cookies development must be accompanied by product quality parameters-determination of shelf life. **Objective:** This study aims to determine growol cookies' shelf-life time with various packaging techniques. **Methods:** This was an observational laboratory study that analyses the shelf life of growol cookies based on the water content on 0 (H-0), 7th (H-7), 14th (H-14), 28th (H-28), 56th (H-56), 90th (H-90) days using three variations of packaging techniques: 1) jar with silica gel, 2) vacuumed polyethylene plastic and 3) aluminum foil. The water content was tested using a thermogravimetric method. This research was carried out at Universitas Respati Yogyakarta from July to October 2022. Water content data were presented descriptively. **Results:** The water content of growol cookies in a jar with silica gel on the 0, 7th, 14th, 28th, 56th, and 90th days were 4.36%; 6.56%; 4.85%; 4.98%; 5.25%; and 6,56%. The water content of cookies in vacuumed polyethylene plastic is 4.98% (H-0); 4.92% (H-7), 4.51% (H-14), 4.53% (H-28), 4.12% (H-56), 6.29% (H-90). The water content of cookies on aluminum foil packaging on the 0, 7th, 14th, 28th, 56th, and 90th days was 6.01%; 6.40%; 3.85%; 5.18%; 3.65%; and 6,68%. **Conclusion:** Cookies with vacuumed plastic packaging have more stable water content according to SNI cookies until day 56th.

Keywords: growol; shelf life; water content analysis

INTRODUCTION

Cookies, a contemporary snack, is favored by almost the entire range of people, from toddlers to the elderly because of the taste that is easily accepted by the senses and its long shelf life (Loza et al., 2017; Pestorić et al., 2019; Sharma & Riar, 2020). Unfortunately, the majority of cookies have a high glycemic index (GI) and low fiber so they are not suitable for certain patients, especially diabetic patients. Various developments have been made to make cookies with good nutritional value (Loza et al., 2017), one of which is to reduce the GI and increase fiber in cookies considering that a low glycemic index and high fiber foods have been shown to reduce blood glucose levels in diabetic patients (Asif, 2014; Previato, 2016).

Growol (a fermented cassava product of Kulonprogo) can be potentially developed as a functional food for diabetic patients. The process of fermenting cassava into growol is able to increase the content of total dietary fiber, water-soluble dietary fiber, and water-insoluble dietary fiber by 25%; 35%; 25% of the initial content (Puspaningtyas et al., 2019). The use of growol flour in making cookies was able to increase total fiber, water-soluble fiber, and water-insoluble fiber by 12%; 53%; 10% compared to control cookies. The GI of growol cookies is lower than glucose but is still in the high category (Puspaningtyas et al., 2020). Another modification attempt has been made with the addition of inulin (Puspaningtyas et al., 2022).

The addition of inulin to the modified growol cookies was able to optimize the role of growol cookies as a snack for diabetic. Growol cookies with the addition of inulin proved to have a low GI with a GI value of 41 (Puspaningtyas et al., 2022). Inulin acts as a prebiotic and can improve gastrointestinal health and maintain the stability of blood glucose levels because of the role of inulin as a dietary fiber. Furthermore, inulin does not change food structure significantly (Abed et al., 2016; Kuntz et al., 2013; Wilson & Whelan, 2017).

The formula for growol cookies with low GI and low glycemic load has been successfully formulated and is ready for the downstream research process into commercial products. To meet commercial food standards, the development of growol cookies must be accompanied by product quality parameters, and one of them is the determination of water content during the storage period. Water content or moisture content can describe the number of microbes in food as a picture of food safety (food shelf-life time) (Brown et al., 2011).

During the storage process, food products can lose food quality. Several factors also affect shelf life such as product characteristics, environment, and packaging (Sudibyo et al., 2010). Besides being determined by the length of storage, the water content of the product

is also determined by the type of packaging used (Correa et al., 2015; Nagi et al., 2012). The goal of the study is to determine the moisture content of growol cookies based on storage time and type of product packaging. The results of this study are expected to provide information about the optimal packaging method and the shelf life of growol cookies. This information becomes one of the important parameters in the process of downstream research products into product ready to be consumed and disseminated as a snack for diabetic patients.

METHODS

This study used an observational laboratory design and analysed the shelf life of growol cookies based on the water content on 0 (H-0), 7^{th} (H-7), 14^{th} (H-14), 28^{th} (H-28), 56^{th} (H-56), and 90^{th} (H-90) days using three variations of packaging techniques: 1) jar with silica gel, 2) vacuumed polyethylene plastic and 3) aluminum foil. This research was carried out at the Laboratory of Chemistry and Microbiology, Universitas Respati Yogyakarta from July to October 2022.

The main ingredient used is growol obtained from local farmers in the Kulonprogo - Yogyakarta. Growol is processed into growol flour through drying technology, referring to the previous study (Puspaningtyas et al., 2019). Additional ingredients for making cookies include wheat flour, cornstarch, skim milk flour, baking powder, non-calorie sugar, butter, egg yolks, and inulin. The manufacture of growol cookies modified the previous formula (Kustanti et al., 2017; Puspaningtyas et al., 2020), especially the addition of 10 grams of inulin.

Cookies are made by mixing the basic ingredients first using a mixer followed by the addition of egg yolks, skim milk flour, wheat flour, growol flour, cornstarch and inulin. After the dough is mixed, the dough is molded into cookies and ends with baking cookies for 20 minutes at a temperature of 160 degrees Celsius (Puspaningtyas et al., 2020).

The water content was tested using the 1995 AOAC thermogravimetric method by drying growol cookies in the oven until the weight of the cookies tended to be stable. The measurement of cookies' moisture content begins with drying the cup in an oven at 100^0C for 15 minutes, then the cup is cooled in a desiccator for 15 minutes. After cooling, the cup was weighed using an analytical balance. Furthermore, as much as ± 1 gram of crushed growol cookies were put into the cup and weighed to determine the initial weight. The growol cookies in the cup then dried in an oven at 100^0C for 15 minutes, then cooled in a desiccator for 15 minutes and weighed. Take the measurements until the weight obtained tends to be stable. Weight reduction is the amount of water contained in growol cookies. The

formula for moisture content (%wb) (Food Safety and Inspection Branch, 2016; Herlina & Nuraeni, 2017):

$$\frac{(weight\ of\ cup\ and\ initial\ sample - weight\ of\ cup\ and\ final\ sample)}{weight\ of\ the\ initial\ sample} \text{ x } 100\%$$

Water content data were presented descriptively. Data analysis presents changes in water content in each different packaging from time to time of storage.

RESULTS AND DISCUSSION

The water content of growol cookies in jar with silica gel (J) on the 0, 7th, 14th, 28th, 56th, and 90th days respectively were 4.36%; 6.56%; 4.85%; 4.98%; 5.25%; and 6,56%. The water content of cookies in vacuumed plastic packaging (P) is 4.98% (H-0); 4.92% (H-7), 4.51% (H-14), 4.53% (H-28), 4.12% (H-56), and 6.29% (H-90). The water content of cookies on aluminum foil packaging (AF) on the 0, 7th, 14th, 28th, 56th, and 90th days was 6.01%; 6.40%; 3.85%; 5.18%; 3.65%; and 6,68% (**Figure 1**). It is known that the moisture content of growol cookies stored using vacuumed plastic packaging is more stable than others. Moisture content of cookies stored using vacuumed plastic packaging in accordance with SNI standards (maximum 5%) until the 56th day (2nd month) (BSN (Badan Standarisasi Nasional), 2011). However, entering the 3rd month, both cookies stored in vacuumed plastic packaging as well as jar and aluminum foil packaging have a higher water content than SNI standard. In other words, the longer cookie products are stored, the higher the moisture content of growol cookies.

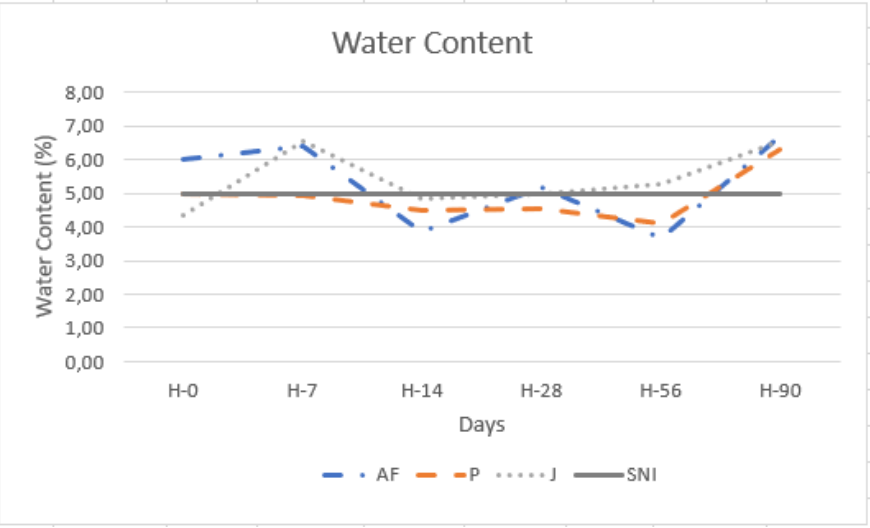

Figure 1. Water Content of Growol Cookies in Various Packaging

This study are in line with prior studies which proved that the longer the flakes were stored, the higher the water content (Herlina & Nuraeni, 2017). Another study of food in powder form proved that coffee stored at different temperatures of 30, 45 and 50 degrees Celsius on days 1st, 8th, 15th, 24th, 30th, 36th, 43rd, and 51st showed the higher the storage temperature, the higher the moisture content; and the longer the storage time, the higher the moisture content (Sudibyo et al., 2010). Studies on cocoa powder storage mentioned that the higher the storage temperature, the higher the moisture content of cocoa powder. Powder textured products tend to be hygroscopic and able to absorb moisture from the surroundings (Hidayati et al., 2021). There is a relationship between water activity, sensory quality, humidity percent and packaging technology (Chowdhury et al., 2011).

Water content often referred to as moisture content is a measurement of the content of free water and bound water. Water content plays a role in confirming the end point of the drying process and knowing the dry weight of the food (Food Safety and Inspection Branch, 2016). Checking the water content is the first step to seeing the potential shelf life of a product. The presence of water vapor absorption from the environment can increase the water content of the product (Hidayati et al., 2021; Sudibyo et al., 2010).

Cookies are hygroscopic foods that are susceptible to additional water absorption which will have an effect on decreasing shelf life (Brown et al., 2011; Correa et al., 2015; Kurniadi et al., 2019). Efforts are needed to maintain the water content of cookies so that the cookies quality is still good. The quality and shelf life of a product is also determined by the packaging materials used. Product packaging can have a significant effect on changing the moisture content of food (Brown et al., 2011).

All packaging systems have a better effect on product quality than open tray storage. The permeability of packaging materials has a great influence on the composition of the internal atmosphere and the optimal storage conditions. For example, perforated plastic bags, both High-Density Polyethylene (HDPE) and Low-Density Polyethylene (LDPE), were found to be the best packaging among all types of packaging to reduce weight loss, avoid mold growth, and maintain better tomato quality for longer duration (Poudel et al., 2022). Plastic jars made from polyethylene terephthalate (PET) have a good oxygen barrier, good moisture barrier, and low light barrier. This packaging also has good heat resistance, rigidity, and strong, and good oil resistance. While aluminum packaging is able to hold oxygen and moisture, but it is not stable to heat (Bauer et al., 2022).

Vacuum packaging has been shown to extend the shelf life of a product (Brown et al., 2011; Chowdhury et al., 2011). Studies conducted on trout showed that when trout was

vacuum-packed in plastic material with low oxygen permeability, the shelf life at 0^0C increased to 20 days (Correa et al., 2015). Vacuum packaging can increase the shelf life of food by limiting the microorganism's growth. Cookies made on a household scale can be stored in the refrigerator for two months and at room temperature for two to three weeks (National Institute of Food Technology and Entrepreneurship and Management, 2021). Mocaf cookies storage technique using polyethylene, metalizing, and aluminum foil packaging has a predicted shelf life of 1.5 months, 12 months, and 19 months (Kurniadi et al., 2019).

In this study, on the 90th day (3rd month) organoleptic testing was carried out to assess the sensory feasibility of cookies. Based on the aroma, there was no foreign odor in cookies with the three variations of cookies storage. The taste test showed that the three packaging variations did not affect the cookies taste. The taste of cookies is still in accordance with the taste of cookies in general. Likewise, from the results of the color, cookies still have a slightly yellow color whether stored in jars, aluminum foil, and vacuumed plastic. However, there is a difference in crispness between cookies stored in jars, aluminum foil, and vacuumed plastic. Cookies stored in a vacuumed plastic are crispier than cookies stored in aluminum foil and jar.

This study showed that on the 90th day the moisture content of cookies stored with aluminum foil (6.68%) and jar (6.65%) was higher than cookies stored in vacuumed plastic (6.29%). In line with prior study, the higher the water content, the less crispy the cookies will be. Storage period and packaging technique affect the water activity and hardness of cookies made from raw and germinated minor millet blends flour. Moisture and water activity increased while the hardness value decreased along with the longer the cookies were stored, but still within safe limits to control the rate of microbial growth (Sharma & Riar, 2020). The shelf life study of Baru (Dipteryx alata Vog.) pulp cookies showed that during the shelf life, moisture and water activity increased due to product absorption, resulting in a decrease in cookie hardness (Ferreira et al., 2020).

Some studies stated that dry food can be stored for up to three months. Packaging techniques have a significant impact on the quality of biscuits (Nagi et al., 2012). Another study showed that fermented cassava flour (FERCAF) has a shelf life of 3 to 4 months at ambient temperature (30^0C, 60% humidity) (Lestari et al., 2019). The shelf-life of germinated pumpkin seed flour biscuits and cookies showed that biscuits and cookies were still organoleptically acceptable on the 60th and 75th days (Kumari et al., 2021).

Biscuits made with pineapple powder can last for 6 weeks at an ambient temperature of 30^0C and a humidity of 75-80% (Thivani et al., 2016). Biscuits from potato waste are known for the first 36 days there is no increase in the water activity and this remains constant for up to 144 days of storage and can be consumed within a period of 180 days (de Morais et al., 2018). The estimated storage of cookies at room temperature (10-25^0C, dry and dark) is 1-2 months (Food Banks Canada, 2018). Meanwhile, the study on arrowroot cookies showed that the statistical test results of variations in storage space humidity had an effect on the crispness and moisture content of arrowroot cookies, but had no effect on color. The shelf life of arrowroot cookies ranged from 106 to 209 days based on the crispness test (Wibowo, 2018).

The shelf life of the product needs to be evaluated to determine the commercialization of the product. Shelf life of product can be estimated using the Accelerated Shelf-Life Testing method by knowing the initial water content, critical moisture content, solid weight of product, packaging surface area, packaging permeability, saturated vapor pressure, and slope sorption isotherm curve (Ekafitri et al., 2021). Shelf life can also be determined by extended storage studies (EES). This ESS method is usually used in conventional methods where producers store a food product in normal daily conditions and observe quality degradation so that the optimal shelf life of a product can be known. The quality of food products will decrease during the storage process (Sudibyo et al., 2010).

CONCLUSIONS AND RECOMMENDATION

Cookies with vacuumed plastic packaging have more stable water content according to SNI cookies until day 56^{th}. This study still has limitations because it only examines the effect of storage time and packaging techniques on water content. Further studies can explore the effect of storage time and packaging techniques with various temperature variations on water activity so that the shelf life of growol cookies can be predicted mathematically.

ACKNOWLEDGEMENTS

Funding of this study is internal grant (contract: 01/Pen/Hibah.Int/PPPM/VI/2022).

REFERENCES

Abed, S. M., Ali, A. H., Noman, A., Niazi, S., Ammar, A.-F., & Bakry, A. M. (2016). Inulin as prebiotics and its applications in food industry and human health; a review. *International Journal of Agriculture Innovations and Research*, *5*(1), 2319–1473.

Asif, M. (2014). The prevention and control the type-2 diabetes by changing lifestyle and dietary pattern. *Journal of Education and Health Promotion*, *3*(1), 1–8. https://doi.org/10.4103/2277-9531.127541

Bauer, A. S., Leppik, K., Galić, K., Anestopoulos, I., Panayiotidis, M. I., Agriopoulou, S., Milousi, M., Uysal-Unalan, I., Varzakas, T., & Krauter, V. (2022). Cereal and confectionary packaging: background, application and shelf-life extension. *Foods*, *11*(697), 1–28. https://doi.org/10.3390/foods11050697

Brown, H., Williams, J., & Kirwan, M. (2011). Packaged product quality and shelf life. In R. Coles & M. Kirwan (Eds.), *Food and Beverage Packaging Technology: Second Edition* (Issue 1993, pp. 59–83). Blackwell Publishing Ltd. https://doi.org/10.1002/9781444392180.ch3

BSN (Badan Standarisasi Nasional). (2011). *SNI Standar Nasional Indonesia Biskuit*. BSN.

Chowdhury, K., Khan, S., Karim, R., Obaid, M., & Hasan, G. (2011). Effect of moisture, water activity and packaging materials on quality and shelf life of some locally packed chanachur. *Bangladesh Journal of Scientific and Industrial Research*, *46*(1), 33–40. https://doi.org/10.3329/bjsir.v46i1.8102

Correa, A. R., Quicazán, M. C., & Hernandez, C. E. (2015). Modelling the shelf-life of apple products according to their water activity. *Chemical Engineering Transactions*, *43*, 199–204. https://doi.org/10.3303/CET1543034

de Morais, M. P., Caliari, M., Nabeshima, E. H., Batista, J. E. R., Campos, M. R. H., & Soares Júnior, M. S. (2018). Storage stability of sweet biscuit elaborated with recovered potato starch from effluent of fries industry. *Food Science and Technology*, *38*(2), 216–222. https://doi.org/10.1590/fst.32916

Ekafitri, R., Kurniawan, Y. R., Desnilasari, D., Surahman, D. N., & Indriati, A. (2021). Shelf-life assessment of energy banana bar using acceleration method with critical moisture content approach. *Food Science and Technology*, *41*(Suppl. 1), 163–168. https://doi.org/10.1590/fst.13120

Ferreira, T. H. B., Florizo, G. kelly M., & Argondona, E. J. S. (2020). Shelf life of cookies made from baru (Dipteryx alata Vog.) pulp under different storage conditions. *Journal of Food Processing and Preservation*, *44*(9), 1–7. https://doi.org/10.1111/jfpp.14702

Food Banks Canada. (2018). *Guidelines for food shelf life* (Vol. 2018, Issue July). info@foodbankscanada.ca

Food Safety and Inspection Branch. (2016). *Water activity vs. water content FACT SHEET #33*. 1–2. foodsafety@gov.mb.ca

Herlina, E., & Nuraeni, F. (2017). Stability the content of nutrition and shelf life prediction flakes flour made from cassava (Manihot esculenta Crantz) flour fortification red beans (Phaseolus vulgaris L.). *Proceeding ICBSI*, *7*(June), 54–58.

Hidayati, S., Sartika, D., Suharyono, & Sutoyo. (2021). Pendugaan umur simpan coklat instan kemasan plastik propilen menggunakan pendekatan model Arrhenius. *Jurnal Teknologi & Industri Hasil Pertanian*, *26*(1), 1–10. http://jurnal.fp.unila.ac.id/index.php/jthp/index

Kumari, N., Sindhu, S. C., Rani, V., & Kumari, V. (2021). Shelf life evaluation of biscuits and cookies incorporating germinated pumpkin seed flour. *International Journal of Current Microbiology and Applied Sciences*, *10*(01), 1436–1443. https://doi.org/10.20546/ijcmas.2021.1001.170

Kuntz, M. G. F., Fiates, G. M. R., & Teixeira, E. (2013). Characteristics of prebiotic food products containing inulin. *British Food Journal*, *115*(2), 235–251. https://doi.org/10.1108/00070701311302212

Kurniadi, M., Khasanah, Y., Kusumaningrum, A., Angwar, M., Rachmawanti, D., Parnanto, N. H. R., & Pratiwi, L. D. (2019). Formulation and shelf life prediction of cookies from modified cassava flour (mocaf) in flexible packaging. *IOP Conference Series: Earth and Environmental Science*, *251*(1), 1–9. https://doi.org/10.1088/1755-1315/251/1/012034

Kustanti, I. H., Rimbawan, R., & Furqon, L. A. (2017). Formulasi biskuit rendah indeks glikemik (batik) dengan subtitusi tepung pisang klutuk (Musa balbisiana colla) dan tepung tempe. *Jurnal Aplikasi Teknologi Pangan*, *6*(1), 12–18. https://doi.org/10.17728/jatp.217

Lestari, D., Elvina, Y., & Kresnowati, M. T. A. P. (2019). Shelf-life evaluation of packaged fermented

cassava flour. *Journal of Engineering and Technological Sciences*, *51*(1), 64–82. https://doi.org/10.5614/j.eng.technol.sci.2019.51.1.5

Loza, A., Quispe, M., Villanueva, J., & Peláez, P. P. (2017). Development of functional cookies with wheat flour, banana flour (Musa paradisiaca), sesame seeds (Sesamum indicum) and storage stability. *Scientia Agropecuaria*, *8*(4), 315–325. https://doi.org/10.17268/sci.agropecu.2017.04.03

Nagi, H., Kaur, J., Dar, B., & Sharma, S. (2012). Effect of strorage period and packaging on the shelf life of cereal bran incorporated biscuits. *American Journal of Food Technology*, *7*(5), 301–310. www.academicjournals.com

National Institute of Food Technology and Entrepreneurship and Management. (2021). *Packaging of cookies*. http:www.niftem.ac.in

Pestorić, M., Sakač, M., Pezo, L., Škrobot, D., Nedeljković, N., Jovanov, P., Filipčev, B., & Mandić, A. (2019). Physicochemical changes of the gluten-free rice-buckwheat cookies during storage – artificial neural network model. *Periodica Polytechnica Chemical Engineering*, *63*(4), 609–617. https://doi.org/10.3311/PPch.13155

Poudel, S., Aryal, P., & Basnet, M. (2022). Effect of different packaging materials on shelf life and postharvest quality of tomato (Lycopersicum esculentum var. Srijana). *Advances in Horticultural Science*, *36*(2), 127–134. https://doi.org/10.36253/ahsc-12801

Previato, H. D. R. de A. (2016). Carbohydrate counting in diabetes. *Nutrition and Food Technology: Open Access*, *2*(2), 1–4. https://doi.org/10.4172/2155-9600.1000288

Puspaningtyas, D. E., Nekada, C. D., & Sari, P. M. (2022). Penambahan inulin terhadap indeks glikemik dan beban glikemik cookies growol: pengembangan makanan selingan diabetes. *AcTion: Aceh Nutrition Journal*, *7*(2), 169–178.

Puspaningtyas, D. E., Sari, P. M., Kusuma, N. H., & Helsius SB, D. (2019). Analisis potensi prebiotik growol: kajian berdasarkan perubahan karbohidrat pangan. *Gizi Indonesia*, *42*(2), 83–90. https://doi.org/10.36457/gizindo.v42i2.390

Puspaningtyas, D. E., Sari, P. M., Kusuma, N. H., & Helsius SB, D. (2020). Indeks glikemik cookies growol: studi pengembangan produk makanan selingan bagi penyandang diabetes mellitus. *Jurnal Gizi Klinik Indonesia*, *17*(1), 34–42. https://doi.org/10.22146/ijcn.54576

Sharma, S., & Riar, C. S. (2020). Effect of storage period and packaging materials on textural, phenolic, antioxidant properties of cookies made from raw and germinated minor millet blends flour. *Annals. Food Science and Technology*, *21*(1), 74–85. http://www.afst.valahia.ro/images/documente/2020/I.8_Seema.pdf

Sudibyo, A., Hutajulu, T. F., & Setyadjit. (2010). Pendugaan masa simpan produk kopi instan menggunakan studi penyimpanan yang di akselerasi dengan model kinetika arrhenius. In *Journal of Agro-Based Industry* (Vol. 27, Issue 1, pp. 12–24).

Thivani, M., Mahendran, T., & Kanimoly, M. (2016). Study on the physico-chemical properties, sensory attributes and shelf life of pineapple powder incorporated biscuits. *Ruhuna Journal of Science*, *7*(2), 32–42. https://doi.org/10.4038/rjs.v7i2.17

Wibowo, N. R. (2018). *Penentuan umur simpan cookies garut (Maranta arundinacea) multi kemasan pada berbagai variasi kelembaban udara ruang penyimpanan dengan motode ASLT dan model keseimbangan massa*. http://etd.repository.ugm.ac.id/

Wilson, B., & Whelan, K. (2017). Prebiotic inulin-type fructans and galacto-oligosaccharides: definition, specificity, function, and application in gastrointestinal disorders. *Journal of Gastroenterology and Hepatology*, *32*(Supp. 1), 64–68.