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THE EFFECT OF USING DIFFERENT TYPES OF THICKENERS IN NONI FERMENTATION WITH ENCAPSULATION TECHNIQUE

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ABSTRACT

Noni is famous for its rich health benefits due to its anti-oncide content, anti-inflamation, and immunomodulatory properties. However, noni is not liked by many people because of its unpleasant taste and aroma so that it becomes an obstacle in its widespread use. Fermentation and Encapsulation techniques on noni are new solutions and innovations to reduce unpleasant tastes and improve the stability of their active compounds during storage and consumption. The objectives of the research are: 1) Making noni fermentation encapsulation and 2) Proximate Test (Protein, carbohydrate, ash and moisture content). The research method includes: 1) producing fermented noni fruit using the encapsulation method, and 2) conducting a Proximate Test. The research design utilizes a Completely Randomized Design (CRD) with a single factor by comparing the effects of noni fermentation and different types of thickeners, namely maltodextrin, xanthan gum, and gelatin, in a 1:2 ratio. Subsequent analysis is performed using SPSS and the BNT (Least Significant Difference) test to determine significant differences. The research findings show that (1) the type of thickener used has a significant effect on moisture content, protein, carbohydrate, and yield; (2) encapsulated fermented noni fruit has a better shelf life compared to liquid fermentation; (3) the lowest moisture content was achieved using maltodextrin as a thickener 9.2%, the highest carbohydrate content with maltodextrin 88.2%, the highest protein content with gelatin 1.6%, the highest ash content with xanthan gum 1.8%, and the highest yield with xanthan gum 0.35%.

Keywords: *Encapsulation; Noni; Proximate*

ABSTRAK

Mengkudu terkenal kaya akan manfaat dibidang kesehatan dikarenakan adanya kandungan antionsidan, anti-inflamai, dan sifat imunomodulatornya. Namun, mengkudu tidak disuka oleh banyak orang dikarenakan rasa, aroma yang tidak enak sehingga menjadi kendala dalam pemanfaatannya secara luas. fermentasi dan Teknik enkapsulasi pada mengkudu menjadi solusi dan inovasi baru untuk mengurangi rasa tidak sedap dan meningkatkan stabilitas senyawa aktifnya selama penyimpanan dan kosumsi. Tujuan penelitian, 1) Pembuatan enkapsulasi

fermentasi mengkudu, 2) Uji Proksimat (Uji protein, karbohidrat, kadar abu, dan kadar air). Metode penelitian ini meliputi 1) pembuatan produk fermentasi buah mengkudu metode enkapsulasi, 2) Uji Proksimat. Rancangan penelitian menggunakan Rancangan Acak Lengkap (RAL) satu faktor dengan membandingkan pemberian fermentasi mengkudu dan pemberian jenis pengental yaitu maltodekstrin, xanthan gum, dan gelatin dengan perbandingan 1:2. Selanjutnya dilakukan analisis menggunakan SPPS dan uji Lanjut BNT untuk mengetahui beda nyata yang dihasilkan. Tempat pelaksanaan akan dilakukan di Laboratorium Pangan Terpadu Fakultas Vokasi. Hasil penelitian menunjukkan bahwa (1) Pemberian jenis pengental berpengaruh secara signifikan pada uji kadar air, protein, karbohidrat, dan rendemen yang dihasilkan; (2) Enkapsulasi fermentasi buah mengkudu memiliki daya simpan lebih baik dibandingkan dengan fermentasi dalam bentuk cairan; (3) Hasil uji kadar air yang paling rendah menggunakan jenis pengental maltodekstrin 9,2%, hasil uji karbohidrat yang paling tinggi menggunakan jenis pengental maltodekstrin 88,2%, hasil uji kadar protein yang paling tinggi menggunakan jenis pengental gelatin 1,6%, hasil uji kadar abu yang paling tinggi menggunakan jenis pengental xanthan gum 1,8%, dan hasil rendemen yang tinggi menggunakan jenis pengental xanthan gum 0,35%.

Kata Kunci: *Enkapsulasi; Mengkudu; Proksimat*

INTRODUCTION

The fermented noni fruit juice drink produced at UD.X has successfully obtained a BPOM distribution permit. This drink is marketed in the Lumajang area. This fermented drink has nutritional content including potassium, zinc, minerals, and Vit C. Orders made at UD. X use the Make To Order system. Encapsulation technology in noni fermentation plays a crucial role in enhancing the effectiveness and longevity of the final product. Encapsulation helps maintain the stability of noni's bioactive compounds, such as antioxidants, anti-inflammatory agents, and antimicrobial components, during storage and distribution. Without encapsulation, these compounds are vulnerable to degradation due to exposure to oxygen, light, and temperature. This fermented drink has a product shelf life of 1 year with a liquid product. Therefore, we innovated to create an encapsulation of fermented noni fruit drinks to extend the shelf life of the product. One of the processing techniques for a food product to extend the shelf life is encapsulation (Rosida et al, 2020).

Encapsulation is the process of coating a material using another material. Other materials intended for encapsulation are as coating materials, external phases or carrier materials (Asri et al., 2021). The morphological image of the encapsulation can be seen in Figure 1. The purpose of encapsulation is to protect substances that are sensitive to the environment, protect organoleptic properties (color, taste, odor), obtain controlled release of drug substances, safe handling of toxic materials. So that with the encapsulation technique, the use of active

ingredients can be applied more freely (Oktavi et al., 2020). The advantages obtained with the encapsulation technique are that handling of active ingredients becomes easier, allowing immobility of active compounds, increasing product stability, increasing material safety, creating a better appearance, the properties of active ingredients can be adjusted (size, structure, color), longer shelf life (Sucianti, 2020).

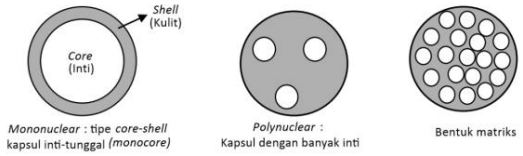

Figure 1. Encapsulation Morphology

Encapsulation technologies that can be used include: coacervation, co-crystallization, spray drying, extrusion, freeze drying, spray cooling, and fluidized bed coating (Garcia et al.,2000). The selection of encapsulation technology needs to be considered based on the type of substance to be encapsulated and the purpose of its application.Encapsulation of agricultural products has been widely carried out, such as encapsulation of dragon fruit, purple sweet potato, torch ginger, rosella flowers, noni fruit and many others (Oktavi et al., 2020). Noni fruit at UD. X is produced into a fermented drink that has been distributed in the Lumajang area. Noni fruit has a high antioxidant content and is useful as a free radical scavenger. Noni fruit contains various bioactive compounds, including vitamins C, B1, B2, B3, and B12, along with alkaloids, anthraquinones, antioxidants, flavonoids, saponins, scopoletin, and natural sugars (Setiawan 2020). One of the encapsulation techniques using additional maltodextrin can bind antioxidants in fruit (Asri et al., 2021). Gelatin can act as a gel-former and fat substitute for animal protein so that its functional characteristics are similar to fat (Anggela, 2023).

Recent studies on noni (*Morinda citrifolia L.*) encapsulation have shown that thickeners such as maltodextrin, gelatin, and xanthan gum significantly impact the stability, bioavailability, and sensory characteristics of encapsulated products. Maltodextrin, often used for its cost-effectiveness and good solubility, has shown promising results in protecting noni's bioactive compounds when used in spray-drying encapsulation, enhancing stability and reducing the characteristic strong odor of noni juice. Combinations with gum acacia further improve bioavailability and moisture control in noni powder, which is beneficial for shelf life and consumer acceptability. In addition, xanthan gum's strong gel-forming properties contribute to particle stability and control over moisture, making it an effective thickening agent for long-term storage.The use of these thickeners demonstrates notable improvements in noni's encapsulation efficiency and health-promoting properties,

paving the way for functional food and supplement applications in the food industry (Zhang et al., 2020; Nguyen et al., 2024)

Therefore, studying the use of thickeners in noni fermentation with encapsulation technology is crucial. Noni has a strong aroma and taste that is often disliked by consumers, and this innovation aims to enhance its acceptance in the market. With this approach, it is hoped that noni products will become more appealing to the public.

MATERIALS AND METHODS

The tools used in the study consisted of 2 components of the tool, namely the tool for making fermented encapsulation of noni fruit and the tool for testing the resulting product. The encapsulation tools include cabinet dryers, cups, digital scales, analytical scales, bowl, erlenmeyer, spoons, mixers, 60 mesh sieves, magnetic stirrers, hot plates, stirring rods, rotary vacuums, evaporators, refrigerators, dark glass bottles. The testing tools include Erlenmeyer flasks, measuring cups, beakers, droppers, measuring pipettes, measuring spoons, measuring flasks, ovens, UV-Vis spectrophotometry, cuvettes, test tubes, vortexes, volumetric pipettes, test tube racks, petri dishes, and rulers.

The chemicals used are analytical grade (PA) (Nisa et al., 2020). The concentrations are maltodextrin at 10-30% (weight/volume), gelatin at 0.5-5% (weight/volume), and xanthan gum at 0.1-1%. The chemicals used are 96% ethanol, Whatman filter paper, tween 80 filter casein, maltodextrin, gum arabic, aquades, methanol, DPPH powder (Sigma Aldrich), phosphate buffer Ph 6, phosphate buffer pH 7, thermamil, NaOH, amyloglucodisase protease, citric acid, toluene, alpha amylase enzyme, pepsin enzyme, beta amylase enzyme, and acetone.

Experimental Design using Completely Randomized Design (CRD) factorial. The provision of noni fermentation and thickener (2:1) which was repeated 3 times. The thickeners used were maltodextrin, gelatin, and xanthan gum. Completely randomized design between Completely Randomized Design (CRD) by comparing the provision of noni fermentation and the provision of thickener refers to Khotimah et al., 2014 and Kurniawan et al., 2019. Furthermore, analysis was carried out using ANOVA inside SPSS and Advanced BNT test to determine the real difference produced. The variables observed included water content, ash, protein, carbohydrates, and yield. Furthermore, it was analyzed ANOVA inside SPSS and Advanced BNT test at the 5% level. Furthermore, the preparation of the encapsulation production process management was carried out to determine whether it was feasible to be produced.

Research Stages:

1. Encapsulation Making

Encapsulation refers to the creation of(Asri et al., 2021)as follows:

a. The noni fruit extraction was macerated using 96% ethanol grade anlaytic solvent and 1% HCL to obtain the filtrate which was then evaporated using a rotary vacuum evaporator to obtain a thick extract. The evaporation extract was dehydrated using a vacuum freeze dryer.

b. Microencapsulation of Noni Fruit Extract using additional coating material, namely maltodextrin dissolved in distilled water. Then the results of the microemulsion mixture are changed into microemulsion using freeze drying. In this study, controlled release measurements were carried out using Gas Chromatography (GC) which was carried out at time intervals of 0, 2, 4, 6 and 8 days.

c. Yield measurement is done by calculating the difference between the final weight obtained and the initial weight which is then expressed as a percentage. The formula for calculation the yield of encapsulation for noni fermentation, is a follow:

$$Yield = \frac{b}{a}\ x\ 100\%$$

b : $Final\ wieght\ of\ encapsulation\ product$

a : $Initial\ weight\ of\ raw\ material$

2. Product Quality Testing

The quality tester of encapsulated products refers to(Budi et al., 2020) The quality of the products tested consists of proximate tests (protein, carbohydrate, ash content and water content tests).

RESULTS AND DISCUSSION

Noni is one of the tropical plants that are often found in various places and has the potential as a natural antioxidant due to the content of flavonoids, tritpenes, triterpenoids, and saonins. Flavonoid compounds contained in noni have antioxidant benefits (Winarsi, 2007). Antioxidant compounds play a role in warding off free radical compounds which can cause degenerative diseases in humans (Prayitno et al., 2024). Free radical instability due to lack of electrons causes health hazards to the body (Ramadhan et al., 2018). Antioxidants have been used to maintain the quality of food products such as damage to rancidity, changes in nutritional value, changes in color, and aroma, and other physical damage to food products due to oxidation so that they can later be inhibited by antioxidants in noni (Laksmi et al.,2020). Thickeners used for encapsulation of fermented noni fruit include maltodextrin, Xanthan Gum, and Gelatin. This thickener is used in food processing and functions as a preservative and thickener to increase food volume. Maltodextrin is usually made from

cassava starch (Nadine et al., 2022). Maltodextrin has high solubility properties, is able to form films, has low hygroscopic properties, forms bodies, low browning properties, fast dispersion processes, and is able to inhibit crystallization and strong binding power (Putra et al., 2013). Xantham gum is one of the hydrocolloids used as a binder because it has good viscosity at low concentrations, when compared to carrageenan. Xanthan gum also does not experience sisneresis. According to Nadiah (2013), Xanthan gum can contribute as much as 56% to the texture of pineapple-rosela fruit leather.

a. Water content

The measurement of water content in the encapsulation of mengkudu fermentation aims to determine the water content of a product with several treatments that are estimated to have better product durability. Water content can determine the freshness and durability of a product. Water has an important role in food ingredients and products because it will affect the appearance, texture, and taste of a food produced (Winarno, 2000).

Water content test on noni fermentation encapsulation using maltodextrin with water content of 9.27%, xanthan gum with water content of 9.47%, and gelatin with water content of 10.57%. which was then carried out the F count test to determine whether there was a significant effect between the treatments. The results of the F count test have obtained that F count 29.92%> F table 9.55 (sig 5%) overall has a significant effect on the encapsulation product of noni fruit fermentation. Furthermore, the BNT test was carried out to determine whether the average of each treatment was different or not. After the BNT test was carried out on the treatment of giving Maltodextrin and Xanthan Gum to encapsulation, there was no difference. However, when compared between Maltodextrin, Xanthan Gum and Gelatin, it turned out to have a difference. This is shown in the results of the Anova table test with different notations. So it can be concluded that the water content obtained was significantly different between Maltodextrin, Xanthan Gum and Gelatin.

Table 1. ANOVA Results of Water Content

Treatment	Average	BNT 5%	Notation
Maltodextrin	9.2790	0.5835	a
Xanthan Gum	9.4750		a
Gelatin	10.5790		b

When compared between the water content of noni fermentation in liquid form with noni fermentation in powder form, namely 97.64% and 9.27%. then noni fermentation in capsule form has a lower water content. So that the shelf life of noni fermentation products (capsules) has a longer shelf life. Where noni fermentation (liquid) has a shelf life of 379 days and the estimated noni fermentation (capsule) has a shelf life of > 379 days. Maltodextrin has a

lower molecular weight (<4000) and a simpler molecular structure, which will have an impact on free water and water bound to the material will be easier to release during the drying process (Garaditjo et al., 2006). The higher the maltodextrin, the lower the water content value. According to Ramadhan et al. (2015), the addition of Xanthan gum will reduce the water content because xanthan gum is a polysaccharide that has a polar group so that water can form hydrogen bonds with hydroxyl groups (-OH), in addition, xanthan gum can bind water up to 32,300 ± H2O / 100 g solid. This is similar to what was stated by Cui (2000), the ability to bind water by xanthan gum can result in a decrease in volume and evaporation of water content so that the free water that is evaporated is reduced (Rizki 2002). Research shows that moisture content is very important in the encapsulation of noni juice, as it affects the stability and bioavailability of bioactive compounds. Low moisture content improves stability and shelf life, while high levels can lead to clumping and decreased bioavailability. The use of carriers such as maltodextrine and gum arabic, for example, optimizes the moisture content during the spray drying process, thereby improving the protection of bioactive compounds and the physical properties and digestibility of the powder (Widjastuti et al. 2023).

b. Carbohydrate

Carbohydrates are natural products that play an important role in plants and animals. Through photosynthesis, plants convert carbon dioxide into carbohydrates in the form of cellulose, starch, and sugars. Carbohydrates in maltodextrin made from cassava consist of carbohydrates in the form of simple sugars, pentose, dextrin, cellulose, and starch (Setiyono 2011). Most carbohydrates, especially monosaccharides and disaccharides such as glucose, fructose, galactose, and lactose, all of which have reducing properties. The reducing properties of these carbohydrates are due to the presence of free aldehyde or ketone groups and free OH groups (Rensia et al., 2023).

Table 2. ANOVA Results of Total Carbohydrates

Treatment	Average	BNT 5%	Notation
Gelatin	82.8075	0.4387	a
Xanthan Gum	87.6335		b
Maltodextrin	88.0220		c

The results of the ANOVA test of total carbohydrates in the encapsulation of noni fermentation with gelatin, xanthan gum, and maltodextrin treatments were significantly different, indicated by F count > F table (876.612 > 9.55). The total carbohydrate value of noni fermentation encapsulation for gelatin treatment was 82.80%, Xanthan gum 87.63%, and maltodextrin 88.02%.

Research on the carbohydrate content in noni encapsulation shows that carbohydrates such as maltodextrine play an

important role in the stability and efficiency of encapsulation. Carbohydrates improve the structural integrity of the encapsulated particles, protecting noni bioactive compounds during storage and processing. Higher carbohydrate content generally improves the smooth flow of powder, solubility, and moisture absorption, which is important for maintaining the bioactivity of noni compounds, thereby extending the shelf life and effectiveness of the product in functional and nutraceutical food applications (Sina et al., 2021)

c. Protein

Protein is a source of amino acids that have elements C, H, O and N that are not owned by fat and carbohydrates. Protein is a component that is widely found in plants and animals. The protein content in food varies. Protein is a source of amino acids. Because of the presence of the element N, the determination of protein levels is usually done by determining the amount of nitrogen (N) in food. The method that usually uses the kjeldahl method where the measurement is based on measuring the total nitrogen content in food.

Table 3. ANOVA Results of Protein Content

Treatment	Average	BNT 5%	Notation
Xanthan Gum	0.0845	0.1423	a
Maltodextrin	0.3825		b
Gelatin	3.9860		c

The results of the ANOVA test of protein content in the encapsulation of fermented noni fruit showed that the treatment of xanthan gum, maltodextrin, and gelatin binders was significantly different, indicated by F count> Fatbel. which was then tested using BNT, indicating that each treatment was significantly different, indicated by different notations.

Research on the protein content in noni fermentation encapsulation shows that higher protein content can improve the structural stability and efficiency of the final product encapsulation. Proteins, such as those derived from gelatin or noni's natural protein content, help form a protective layer around the bioactive compounds, increasing bioavailability and shelf life in powder form. In addition, the protein content also contributes to moisture retention, which improves the texture and durability of encapsulated noni products in various formulations.

d. Ash Content

Ash content is a mixture of inorganic components/mineral elements in a food ingredient and is an organic residue resulting from the combustion or oxidation process of organic components of the food ingredient. Ash content in food ingredients indicates the presence of mineral content in the ingredient, as well as the cleanliness and purity of a product produced (Mega 2024).

The test of ash content in noni fermentation encapsulation provides an indication of the mineral content and the

effectiveness of the encapsulation process in maintaining bioactive compounds. Higher ash levels can indicate an increase in the mineral content in the final product, but they can also be an indicator of the presence of residues or carrier materials that are not completely dissolved. Ash content control is important to ensure product quality, because ash levels that are too high can affect the taste, stability, and consumer attractiveness of the encapsulated product.

Table 4. ANOVA Results of Ash Content

Treatment	Average	BNT 5%	Notation
Maltodextrin	1.3610	0.1006	a
Gelatin	1.6180		b
Xanthan Gum	1.8125		c

The results of the ANOVA test of ash content in the encapsulation of noni fermentation in the treatment of maltodextrin, gelatin, and xanthan gum had a significant effect (F count > F table). Then continued with the BNT test on encapsulation which was significantly different. The characteristics of the type of thickener were different and had a significant effect on the encapsulation of noni fermentation.

The higher the amount of xanthan gum given, the higher the ash content produced. According to Garcia (2000), the ash content in xanthan gum reaches 7-12%. Then, the minerals in xanthan gum are 0.35-0.65% calcium, 0.40-0.56% potassium and 0.55-0.69 for sodium (Lee 2000).

e. Yield

Yield is the ratio of the amount of extract to the amount of material extracted. The yield unit is percent (%). The higher the yield value produced, the higher the extract produced. The yield calculation is obtained by calculating the final weight of the powder divided by the initial weight and then multiplied by one hundred percent.

Table 5. Initial and final weight

Thickening	Initial Weight (g)	Final Weight (g)	Yield %
Maltodextrin	500	150	0.3
Xanthan Gum	500	175	0.35
Gelatin	500	100	0.2

The yield of an extract is influenced by several factors including the type of solvent and its concentration. The solvent used in the manufacture of noni fermentation encapsulation has a function as a mass enhancer. The types of thickeners used in noni fermentation encapsulation are maltodextrin, xanthan gum, and gelatin, the higher the yield produced. This is because the solvent that will be used in the encapsulation of noni fermentation can increase the volume and increase the total solids of a material so that the resulting yield will be higher. The total solids in the dried material will also affect the resulting yield. In addition, it should be noted that the type of solvent also affects the resulting yield. The solvents used for the process of making noni fermentation encapsulation have

different characteristics. Maltodextrin solvent

CONCLUSIONS

The research results obtained:

The type of thickener given has a significant effect on the water content 9% - 10%, protein 1% - 4%, carbohydrate 82 % - 88% and yield content 0,2% - 0,3% for all thickener.

Encapsulation of noni fruit fermentation has better shelf life compared to fermentation in liquid form. The production of noni fermentation encapsulation recommended in this study utilizes maltodextrin as the thickening agent.

The lowest water content test results used the maltodextrin thickener type, the highest carbohydrate test results used the maltodextrin thickener type, the highest protein content test results used the gelatin thickener type, the highest ash content test results used the xanthan gum thickener type, and the highest yield results used the xanthan gum thickener type.

RECOMMENDATIONS

Noni fermented encapsulation products should be further analyzed, namely antioxidant tests, product shelf life, and organoleptic tests.

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