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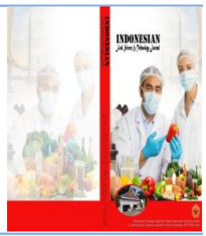

Dextrose Equivalent (DE) Variation and Maltodextrin Concentration Effects in Yoghurt Powder Characteristics Using Foam-mat Drying

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Abstract*— Lactic Acid Bacteria (LAB) in yoghurt is a probiotic bacteria which potentially improves intestinal health. Yoghurt has a high moisture content. Thus, storing it at low temperatures can maintain the stability of microbes in the yoghurt. Yoghurt stored in the refrigerator has a maximum shelf life of 10 days. Yoghurt powder is one of the alternative solutions to prolong the shelf life. This study used a randomized design of factorial groups with variations of dextrose equivalent (DE) values of 10-12 and 18-20, as well as variations of maltodextrin concentrations of 10, 15, and 20%. The study aimed to determine the DE value and maltodextrin concentration which can produce the best quality synbiotic yoghurt powder. The quality of this synbiotic yoghurt was assessed by the highest yield, lowest water content, highest solubility, highest water absorption, highest acidic titrated total, highest total of lactic acid bacteria, and highest organoleptic. The study obtained that the high DE value of maltodextrin affected the total LAB. Meanwhile, the high concentration of maltodextrin will increase yield, solubility, total of LAB, and decrease moisture content, water absorption capacity, and acidic titrated total. The interaction between the DE value and the concentration of maltodextrin did not affect all the parameters of this study.

***Keywords*— DE Value, Maltodextrin, Powder, Yoghurt**

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I. INTRODUCTION

Yoghurt is a dairy product fermented with Lactic Acid Bacteria (LAB) Magnusson et al., 2002, cited in [1]. Yoghurt containing a probiotic LAB can enhance intestinal physiological function and the intestinal microbiota, both of which contribute to maximizing the body's health conditions [2]. Probiotic bacteria in the digestive tract can be stimulated by adding prebiotic components, one of which is inulin, extracted from taro tubers. Combining probiotic elements with prebiotic ingredients has benefits that can improve the quality of yoghurt. Yoghurt must be stored at a low temperature because keeping it at low temperatures can control the proliferation of microorganisms. Therefore, an alternative form of yoghurt, powder form, is needed to extend storage temperatures and increase shelf life.

The foam mat drying method is a technique for drying liquid material that has been transformed into foam by adding foaming and heat-resistant agents [3]. In order to affect the growth of probiotic bacteria in yoghurt, the foam drying process employs a relatively high temperature, usually between 45 and 70°C. Temperature has an impact on the viability and proliferation of probiotic microorganisms. Therefore, the probiotics' viability must be protected during the drying process by a coating or encapsulant substance like maltodextrin. Maltodextrin is an ingredient often used in making dried foods because, apart from being a filler, maltodextrin has several advantages, including having no effect on taste and being readily soluble in water. Based on a previous study [4], the DE (dextrose equivalent) value of maltodextrin shows the total reducing value of starch or modification products in percent units. It is the main factor influencing the properties of maltodextrin.

Researchers used several variations of DE maltodextrin (10-12 and 18-20) and concentrations (10, 15, and 20%) in this study. This research aims to determine the effects of variations in dextrose equivalent (DE) values and maltodextrin concentrations and the interaction between these variations in making powdered yoghurt using the foam mat drying method.

II. MATERIAL AND METHODS

A. Material

The tools used in this research included a centrifuge (Gemmyco, PLC-036), mixer (Philips, HR1559), blender (Philips, HR2115), hot plate (Thermo-scientific), analytical balance (Excellent, H7K), incubator, refrigerator (Sanken), freezer (Sanken), autoclave (Autoclave electric vertical GEA, YXQ-50L), vortex (DLAB MX-S), micropipette (Dragon Lab), cabinet dryer, moisture oven (Memmert, UN55), water bath (B-One, OWBC-50L-214), desiccator, Duran bottle, petri dish, pipette, beaker, measuring cup, test tube, centrifuge tube, stirrer, Bunsen lamp, baking pan, spatula, spoon, thermometer, cup, glass small, teapot, jar, tip, stir bar, volumetric flask, Erlenmeyer flask, burette, stative, and volume tube.
Meanwhile, the materials involved full cream liquid milk (Frisian Flag), LAB starter (Yogurmet), maltodextrin with DE 10-12 and 18-20, sugar (Gulaku), taro (used as inulin), methylcellulose (method), baking paper, label, spirit, 70% alcohol, distilled water, MRSA (Himedia), NaCl (Himedia), zip plastic, Whatman filter paper no. 42, NaOH (Merck), oxalic acid, and phenolphthalein (Merck).

B. Methods

This experimental research was conducted at the Microbiology and Food Safety Laboratory, Food Engineering and Processing Laboratory, Food Analysis Laboratory, and Food Technology Department of Sultan Ageng Tirtayasa University. The research was carried out from June to December 2022.
This research employed a factorial randomized block design with two treatment factors. The first factor was the variation in the DE value of maltodextrin (D), which consisted of 2 levels, namely 10-12 and 18-20. In contrast, the second factor was the concentration of maltodextrin (M), composed of 3 groups, namely 10, 15, and 20%. The combination of these two factors produced six treatments, with each treatment being repeated four times to obtain 24 experimental units.
The collected data included water content measured using the gravimetric method [4], yield [5], total Lactic Acid Bacteria (LAB) [6], total titrated acid [7], solubility [8], water absorption [9], FTIR [10], SEM [11] and organoleptic tests, including colour, taste, Aroma, texture, and overall assessment, which were evaluated by 30 panellists using a 7-point scale: 1 = Very Dislike, 2 = Dislike, 3 = Dislike Somewhat, 4 = Neutral, 5 = Somewhat Like, 6 = Like, and 7 = Like Very Much.

III. RESULT AND DISCUSSION

A. First Phase of the Research

The following is a recapitulation of the results of the variance analysis of the response to the influence of the Dextrose Equivalent (DE) value and maltodextrin concentration on powdered yoghurt using the foam mat drying method. **Table 1** contains the analysis of variance in quantitative testing.

TABLE 1
RECAPITULATION OF RESULTS FOR VARIOUS RESPONSES TO DE VARIATION AND MALTODEXTRIN CONCENTRATION IN POWDERED YOGHURT USING THE FOAM MAT DRYING METHOD

No	**Observation Parameters**	**Treatment**			**Group**	**KK (%)**
		D	**M**	**D x M**		
1	Rendement	ns	**	ns	**	1.64
2	Water content	ns	**	ns	**	8.03
3	Total Titrated Acid	ns	**	ns	**	6.52
4	Solubility	ns	**	ns	ns	5.39
5	Water Absorption Capacity	ns	ns	ns	ns	6.21[a]
6	Total Lactic Acid Bacteria	**	**	ns	**	2.67

Description:
D = DE Maltodextrin
M = Maltodextrin Concentration (%)
DxM =Interaction between DE maltodextrin and maltodextrin concentration (%)
KK = Diversity coefficient
ns = Not significant
* = Significant
** = Very significant
a = Transformed data √x

B. Yield

According to the results of the response analysis, variations in the DE value had no significant effect (P-value < 5%) on the yield of powdered yoghurt. In contrast, the concentration of maltodextrin had a considerable impact (P-value > 5%) on the properties of powdered yoghurt. The average yield value for powdered yoghurt was 25.26%, and the complete results can be seen in Table 2.

TABLE 2
EFFECT OF DEXTROSE EQUIVALENT (DE) AND MALTODEXTRIN CONCENTRATION ON YIELD IN POWDERED YOGHURT USING FOAM MAT DRYING METHOD

DE maltodextrin	**Maltodextrin concentration (%)**			**Average**
	10 (M_1)	**15 (M_2)**	**20 (M_3)**	
10-12 (D_1)	22.11	25.50	27.96	25.19[a]
18-20 (D_2)	22.09	25.40	28.49	25.33[a]
Average (%)	22.10[a]	25.45[b]	28.23[c]	25.26

Description: Numbers followed by different lowercase letters in rows or columns are significantly different based on the DMRT test at the 5% level.

In the results of **Table 2**, the concentration of maltodextrin significantly affected the yield of powdered yoghurt. The higher concentration of maltodextrin produced the higher work. The maltodextrin concentration of 20% was substantially different from that of 15% and 10%. This was because adding a higher concentration of maltodextrin increased the total solids in powdered yoghurt. This assumption was supported by research conducted by Yana and Kusnadi [10], who found that adding a high concentration of maltodextrin produces a product with a high yield. According to Miskiyah et al. [11], the increase in profit was influenced by the large amount of maltodextrin added. By adding maltodextrin, the total solids and yield increased.

C. Water Content

According to the analysis of the DE value response to the water content of powdered yoghurt using the foam mat drying method, there was no significant effect (P-value > 5%). In comparison, the maltodextrin concentration had a significant impact (P-value < 5%). The average water content of powdered yoghurt was 4.98%, and the complete results can be seen in **Table 3**.

TABLE 3
EFFECT OF DEXTROSE EQUIVALENT (DE) OF MALTODEXTRIN AND MALTODEXTRIN CONCENTRATION ON WATER CONTENT IN POWDERED YOGHURT USING FOAM MAT DRYING METHOD

DE maltodextrin	Maltodextrin concentration (%)			Average
	10 (M_1)	15 (M_2)	20 (M_3)	
10-12 (D_1)	5.34	5.07	4.78	5.06
18-20 (D_2)	5.66	4.82	4.22	4.90
Average (%)	5.50^{b}	4.95^{ab}	4.50^{a}	4.98

Description: Numbers followed by the same lowercase letter in a row or column are not significantly different based on the DMRT test at the 5% level.

A 10% maltodextrin concentration had the highest water content, 5.50%, and a 20% maltodextrin concentration had the lowest water content, 4.50%. Increasing the maltodextrin will decrease the water content. In Table 3, attention had a significant effect on the water content of powdered yoghurt. This was caused by maltodextrin, which could bind free water in a material. This was confirmed by previous research conducted by Masykur and Kusnadi [12], indicating that adding a higher concentration of maltodextrin lowered the water content of powdered yoghurt. Consequently, the product's viscosity increased, and the lower water content sped up the drying process because less water needed to be evaporated.

D. Total Titrated Acid

According to the analysis of the DE value response to the total titrated acid of powdered yoghurt using the foam mat drying method, there was no significant effect (P-value > 5%). In contrast, the maltodextrin concentration had a significant impact (P-value < 5%). The average total titrated acid value of powdered yoghurt was 1.00%, and the complete results can be seen in **Table 4.**

TABLE 4
EFFECT OF DEXTROSE EQUIVALENT (DE) OF MALTODEXTRIN AND MALTODEXTRIN CONCENTRATION ON TOTAL TITRATED ACID IN POWDERED YOGHURT USING FOAM MAT DRYING METHOD

DE maltodextrin	Maltodextrin concentration (%)			Average
	10 (M_1)	15 (M_2)	20 (M_3)	
10-12 (D_1)	1.18	1.02	0.87	1.02^{a}
18-20 (D_2)	1.09	0.98	0.88	0.98^{a}
Average (%)	1.13^{a}	1.00^{b}	0.88^{c}	1.00

Description: Numbers followed by the same uppercase/lowercase letter in a row or column are not significantly different based on the DMRT test at the 5% level.

The concentration of maltodextrin significantly affected the total titratable acid of powdered yoghurt at a significance level of 5%. The highest value for the TAT parameter was 1.13%, which was obtained with the addition of 10% maltodextrin. By adding more maltodextrin, a lower TAT value was obtained. This was supported by Purwanti et al. (2008) cited in [7], who stated that adding more maltodextrin resulted in a lower total titrated acid of rehydrated powdered yoghurt. The total titratable acid of powdered yoghurt showed an inverse relationship with pH. During fermentation, lactic acid bacteria would use carbohydrates to form acid. Djali, Indiarto, and Avila [13] added that adding maltodextrin from 5-30% significantly reduced the total titratable acid to 0.31% in sword bean powdered yoghurt. Djali, Marta, and Harnah [14] reported that adding a maltodextrin concentration of up to 30% significantly reduced the total titratable acid to 0.56% in soybean powdered yoghurt.

E. Solubility

The DE value response analysis results on the solubility of powdered yoghurt using the foam mat drying method showed no significant effect (P-value > 5%). In comparison, the maltodextrin concentration had a significant impact (P-value < 5%). The average solubility value of powdered yoghurt was 74.44%, and the complete results can be seen in **Table 5.**

TABLE 5
EFFECT OF DEXTROSE EQUIVALENT (DE) OF MALTODEXTRIN AND MALTODEXTRIN CONCENTRATION ON SOLUBILITY IN POWDERED YOGHURT USING FOAM MAT DRYING METHOD

DE maltodextrin	Maltodextrin concentration (%)			Average
	10 (M_1)	15 (M_2)	20 (M_3)	
10-12 (D_1)	71.75	73.32	76.61	73.89
18-20 (D_2)	72.09	74.17	78.73	75.00
Average (%)	71.92^{a}	73.74^{ab}	75.17^{b}	74.44

Description: Numbers followed by the same lowercase letter in a row or column are not significantly different based on the DMRT test at the 5% level.

In Table 5, it can be seen that the concentration of maltodextrin does not have a significant effect on solubility. The highest solubility was obtained with 20% maltodextrin, 75.17%, and the smallest solubility, 71.92%, was received with 10% maltodextrin. The higher the concentration of maltodextrin, the higher the solubility of yoghurt powder. Even though it is not statistically significant, the actual data shows an increase in solubility According to Ernawati, Khasanah, and Anandito [15], the increased solubility is caused by maltodextrin having a high DE value, so the solubility of maltodextrin is excellent. Maltodextrin with a high DE is more hygroscopic and has a higher bulk density than low DE maltodextrin. Increasing bulk density and hygroscopic properties cause a significant difference in water vapour pressure between solids and liquids. Consequently, the higher the ability of particles to absorb water on their surface or the faster the time required for the material to be wetted by water, the greater the rehydration power becomes. This, in turn, increases yoghurt solubility.

F. Water Absorption Capacity

According to the results of the response analysis of the DE value and maltodextrin concentration on the water absorption capacity of powdered yoghurt using the foam mat drying method, there was no significant effect (P-value > 5%). The average water absorption value of powdered yoghurt was 1.19 mL/g; the complete results can be seen in **Table 6.**

TABLE 6
EFFECT OF DEXTROSE EQUIVALENT (DE) OF MALTODEXTRIN AND MALTODEXTRIN CONCENTRATION ON WATER ABSORPTION CAPACITY OF POWDERED YOGHURT USING FOAM MAT DRYING METHOD

DE maltodextrin	**Maltodextrin concentration (%)**			**Average**
	10 (M_1)	**15 (M_2)**	**20 (M_3)**	
10-12 (D_1)	1.10	1.13	1.10	1.11
18-20 (D_2)	1.18	1.58	1.05	1.27
Average (%)	1.14	1.35	1.08	1.19

Description: Numbers followed by the same uppercase/lowercase letter in a row or column are not significantly different based on the DMRT test at the 5% level.

According to the results of the response analysis of the DE value and maltodextrin concentration on the water absorption capacity of powdered yoghurt using the foam mat drying method, there was no significant effect (P-value > 5%).
In Table 6, the DE value and maltodextrin concentration did not significantly affect the water absorption capacity of powdered yoghurt. The water absorption capacity of powdered yoghurt ranged from 1.05 to 1.58 mL/g. Yoghurt powder with DE 18-20 and a maltodextrin concentration of 15% had the highest water absorption capacity, 1.58 mL/g. The water-binding ability of maltodextrin was influenced by the DE value [16]. Maltodextrin with low DE was non-hygroscopic, while maltodextrin with high DE tends to absorb water. The higher concentration of maltodextrin increased the number of hydroxyl groups, allowing it to bind more water from the environment, and the reabsorption of water vapour also increased. This was caused by the hydrophilic maltodextrin groups on the product's surface, so the ability to bind water from the air was fast due to a layer of maltodextrin [17].

G. Total LAB

The results of the analysis of the DE value response to total lactic acid bacteria in powdered yoghurt using the foam mat drying method had a significant effect (P-value < 5%). In contrast, the maltodextrin concentration had no significant impact (P-value > 5%). The average total LAB value of powdered yoghurt was 8.51 log cfu/g; the complete results can be seen in **Table 7.**

TABLE 7
EFFECT OF DEXTROSE EQUIVALENT (DE) OF MALTODEXTRIN AND MALTODEXTRIN CONCENTRATION ON TOTAL LACTIC ACID BACTERIA (LAB) IN POWDERED YOGHURT USING FOAM MAT DRYING METHOD

DE maltodextrin	**Maltodextrin concentration (%)**			**Average**
	10 (M_1)	**15 (M_2)**	**20 (M_3)**	
	Log cfu/g			
10-12 (D_1)	8.13	8.32	8.56	8.34[a]
18-20 (D_2)	8.47	8.67	8.89	8.68[b]
Average (%)	8.30[a]	8.50[b]	8.72[c]	8.51

Description: Numbers followed by different lowercase letters in rows or columns are significantly different based on the DMRT test at the 5% level.

In Table 7, it can be seen that DE maltodextrin had a significant effect on total LAB in powdered yoghurt. Data from the analysis of the entire LAB of yoghurt powder showed that DE 18-20 had a higher real LAB, with an average of 8.68 log cfu/g, compared to DE 10-12, with an average of 8.34 log cfu/g. The higher the DE in maltodextrin, the more its properties were as a coating. According to Sumanti et al. [18], maltodextrin is a derivative of oligosaccharides, which are energy materials for the growth of good bacteria (prebiotics) because the components of maltodextrin are classified as complex carbohydrates.
In Table 7, it can also be seen that the concentration of maltodextrin had a significant effect on the total LAB in powdered yoghurt. The results showed that the total LAB of yoghurt powder with varying maltodextrin concentrations had an average total LAB value ranging from 8.30 to 8.72 log cfu/g. According to the Indonesian National Standard 2981:2009, the minimum amount of LAB in yoghurt after fermentation is 10^7 cfu/ml or 7 log cfu/g. The higher the concentration of maltodextrin produced, the higher the total LAB. Powdered yoghurt with a maltodextrin concentration of 20% had a higher average total LAB value of 8.72 log cfu/g compared to a maltodextrin concentration of 15%, which was 8.50 log cfu/g, and 10%, which was 8.30 log cfu/g. This was likely due to the nature of maltodextrin as a coating. According to Sugindro et al. (2008), cited in [19], the encapsulation efficiency increased with higher coating concentration, and the shell layer became better and more robust. This allowed it to protect the core

material and preserve substances that quickly evaporated during the drying process, resulting in increased retention of the core material.

H. Organoleptic Test

This organoleptic test was carried out to determine the level of panellists' liking for a product. The parameters tested included colour, aroma, texture, taste, and overall. The organoleptic test results can be seen in **Table 8.**

TABLE 8
EFFECT OF DEXTROSE EQUIVALENT (DE) OF MALTODEXTRIN AND MALTODEXTRIN CONCENTRATION ON ORGANOLEPTIC CHARACTERISTICS IN POWDERED YOGHURT USING FOAM MAT DRYING METHOD

Sample	**Test Parameters**				
	Colour	**Aroma**	**Texture**	**Flavour**	**Overall**
D1M1	4.40	4.80	3.93	4.33	4.33
D1M2	4.43	4.60	3.67	4.37	4.23
D1M3	4.50	4.33	3.63	4.13	3.96
D2M1	4.37	4.77	3.93	4.10	4.23
D2M2	4.43	4.76	3.77	4.10	4.30
D2M3	4.63	4.57	3.90	4.50	4.53

Description: 1 = strongly dislike, 2 = dislike, 3 = somewhat dislike, 4 = neutral, 5 = somewhat like, 6 = like, 7 = like very much.

Data from the organoleptic colour analysis of powdered yoghurt showed that D2M3 had a higher value than other yoghurts, with a score of 4.63 (neutral to somewhat favourable). Panellists preferred powdered yoghurt with a maltodextrin concentration of 20% compared to yoghurt with a 10% and 15% maltodextrin concentration. The higher the maltodextrin concentration, the brighter the yoghurt would be. This was supported by research conducted by Tias [20], which showed that the number of polysaccharide molecules from maltodextrin increases as the concentration of maltodextrin increases, resulting in a brighter product colour.

Table 8 shows that D1M1 powdered yoghurt with DE 10-12 and adding 10% maltodextrin had a higher value, 4.80 (neutral to somewhat favourable), than the other samples. This was because adding 15% and 20% maltodextrin caused the characteristic aroma of yoghurt to become slightly reduced. Based on the CoA from Yi Shui Dadi Corn Development [21], maltodextrin has a malt-dextrin aroma, so adding more maltodextrin covered the smell of powdered yoghurt. Consumers tended to prefer yoghurt products with a slightly sour smell.

Table 8 shows that powdered yoghurt with a concentration of 10% had a more favourable texture than the others. The surface of powdered yoghurt had a value that tended to be minor, ranging between 3.63 and 3.93 (somewhat disliked to neutral). The sample was not smooth enough during grinding and did not go through the sieving stage, so the resulting texture was undesirable.

In Table 8, it can be seen that the taste of D2M3 powdered yoghurt had a higher value than the others. This was because the taste of rehydrated powdered yoghurt was sour. The sour taste in yoghurt comes from lactic acid and other organic acids after fermentation. The addition of maltodextrin, which has no flavour [21], also affected the taste of powdered yoghurt, where the more maltodextrin concentration was added, the sour taste of rehydrated powdered yoghurt decreased.

The test results with the overall parameter provided a value for this parameter that ranged from 3.96 to 4.53, where this value fell into the category of somewhat disliked to somewhat liked. Of all the parameters tested (colour, aroma, texture, taste, and overall), only the texture parameter slightly opposed neutral results. In contrast, the other parameters showed neutral to somewhat liked results. Based on the hedonic organoleptic test results above, this product was acceptable but required reformulation to increase solubility to provide a more favouruable texture (fully dissolved).

I. Determining the Best Treatment for Yoghurt Powder

Powdered yoghurt was tested for yield content, water content, total titrated acid, solubility, water absorption capacity (DSA), total lactic acid bacteria (LAB), and organoleptic evaluation. The best sample treatment was selected based on the best analysis results for each parameter. The matrix for determining the best-powdered yoghurt formulation treatment for each parameter can be seen in **Table 9.**

TABLE 9
MATRIX FOR DETERMINING THE BEST POWDERED YOGHURT FORMULATION TREATMENT FOR EACH PARAMETER

Treatment Combination	**D_1M_1**	**D_1M_2**	**D_1M_3**	**D_2M_1**	**D_2M_2**	**D_2M_3**
Rendement						■
Water content						■
TAT	■					
Solubility						■
DSA					■	
Total LAB						■
Organoleptic						
a. Colour						■
b. Aroma	■					
c. Texture	■					
d. Flavour						■
e. Overall						■

Description:
Blue = Shows the best value for each parameter
D_1 = DE 10-12
D_2 = DE 18-20
M_1 = Maltodextrin Concentration 10%
M_2 = Maltodextrin Concentration 15%
M_3 = Maltodextrin Concentration 20%

Based on the results of the matrix table above, it is known that the powdered yoghurt treatment formulation with a DE value of 18-20 and a maltodextrin concentration of 20% (D2M3) was the sample with the best treatment formulation in this study. This was supported by research conducted by Tahir [22], which showed that 20% concentration of maltodextrin was the best concentration in making of tea-sappanwood effervescent Powdered yoghurt combined with D1M1 treatment produced the best total titratable acid (TAT) values and organoleptic parameters, including aroma and texture. Powdered yoghurt with various D2M3 treatments had the best yield, water content, solubility, total LAB, and organoleptic parameters, including colour, taste, and overall.

J. FTIR

FTIR spectra of different yoghurt powders are presented in Fig.1. Similar structural patterns were found in all yoghurt powder samples, indicating that the differences in DE 10-12 and 18-12 did not have a major influence on the peak changes. The large peak at the front indicates the presence of OH stretching vibrations so that hydroxyl compounds (acids) can be characterized (1) (3269-3285 cm^{-1}) similar to Hassani [24] are 3330.64 and 3332.17 cm^{-1}.

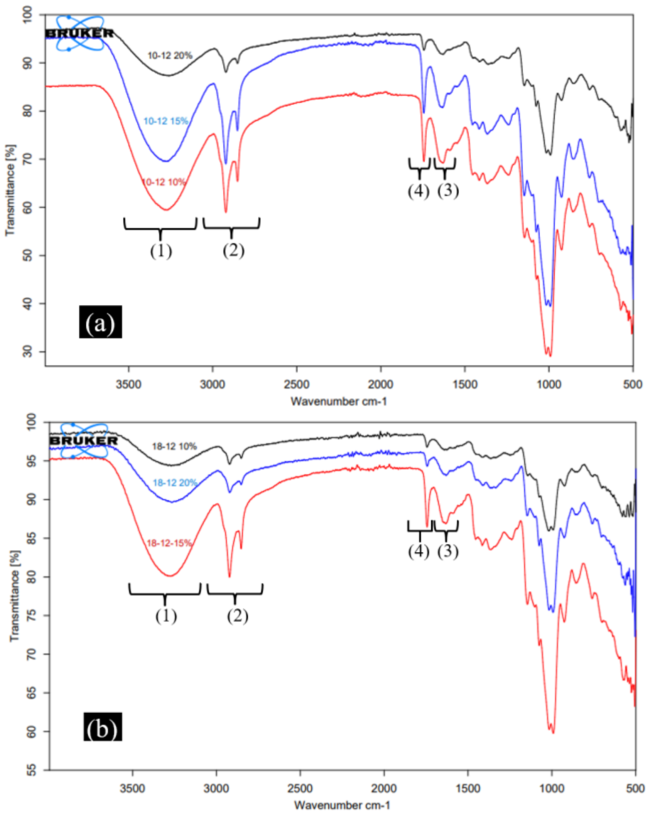

Fig. 1 FTIR spectrum of yoghurt powder (a) DE 10-12 and (b) DE 18-12

In addition, the next two peaks which are similar in all treatments, show the absorption band of long-chain linear aliphatic compounds (2) at 2921-2852 cm^{-1}. Furthermore, the absorption band (3) at 1926-1930 cm^{-1} indicates the presence of amide C=O, and the previous peak (4) at 1742 indicates the presence of ester, a simple carbonyl compound in yoghurt food fiber. The 1500-500 cm^{-1} region is usually called the fingerprint region which indicates the presence of C-O, C-C, C-H, and C-N bonds.

K. SEM

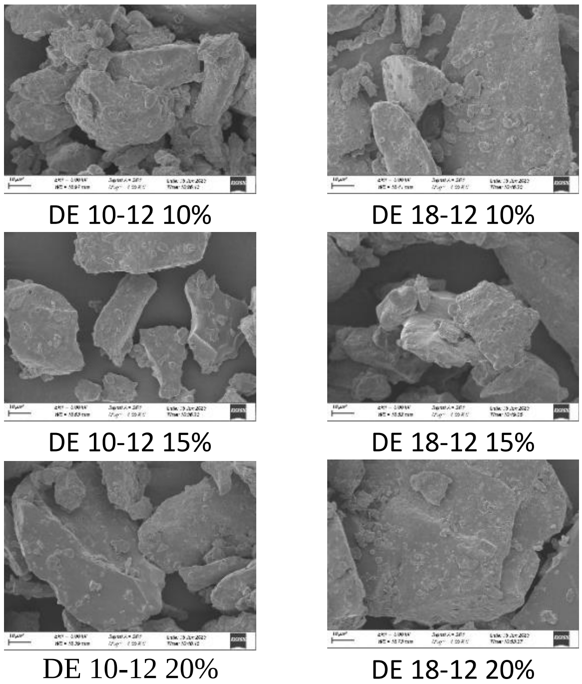

Fig. 2 Microstructure of Yoghurt Powder

Scanned pictures of yoghurt powder are shown in Fig. 2. In general, the difference in dextrose equivalent has no effect on the morphological structure of yogurt powder. They all presented porous and irregular structures similar to Malik [25]. The results show the three-dimensional structure of protein and casein micelles. In all yogurt powder treatments, there were small holes indicating the presence of fat globules.

IV. CONCLUSION

A. Conclusion

The best DE of maltodextrin in making powdered yoghurt was found to be DE 18-20 and had a significant influence on total LAB but did not have a substantial impact on several parameters such as yield, water content, total titrated acid, solubility, water absorption, and all organoleptic parameters (colour, aroma, texture, taste, overall). The best concentration of maltodextrin in making powdered yoghurt was found to be 20%, and it had a significant effect on yield, water content, total titrated acid, solubility, and total LAB.

V. ACKNOWLEDGEMENTS

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REFERENCES

[1] M. V. Pratana, V. I. Meitiniarti, and A. B. A. Sukmana, "Uji viabilitas bakteri asam laktat dalam enkapsulasi menggunakan alginat dan susu skim secara kering dingin," in *Peningkatan Kualitas Publikasi Ilmiah melalui Hasil Riset dan Pengabdian kepada Masyarakat*, Jakarta: Institute for Research and Community Services (LPPM) Universitas Indraprasta PGRI, Nov. 2019, pp. 484–495.

[2] D. H. Rahman, I. Tanziha, and S. Usmiati, "Formulasi produk susu fermentasi kering dengan penambahan bakteri probiotik Lactobacillus Casei dan Bifidobacterium Longum.," *Indonesian Journal of Nutrition and Food*, vol. 7, no. 1, pp. 49–56, 2012.

[3] A. Febrianto, S. Kumalaningsih, and A. Windi Aswari, "Process engineering of drying milk powder with foam mat drying method: A study of the effect of the concentration and types of filler," *Journal of Basic and Applied Scientific Research*, vol. 2, no. 4, pp. 3588–3592, 2012.

[4] Association of Official Analytical Chemyst [AOAC], "Official method of analysis of the association of official analytical of chemist," Virginia, 2005.

[5] B. Koc, M. S. Yilmazer, P. Balkır, and F. K. Ertekin, "Spray drying of yoghurt: optimization of process conditions for improving viability and other quality attributes," *Drying Technology*, vol. 28, no. 4, pp. 495–507, Mar. 2010, doi: 10.1080/07373931003613809.

[6] I. R. Hidayat, Kusrahayu, and S. Mulyani, "Total bakteri asam laktat, nilai pH dan sifat organoleptik drink yoghurt dari susu sapi yang diperkaya dengan ekstrak buah mangga," *Animal Agriculture Journal*, vol. 2, no. 1, pp. 160–167, 2013.

[7] M. Abdi, "Pengaruh penambahan maltodekstrin dan lama pengeringan terhadap yoghurt bubuk biji nangka (Artocarpus Heterophyllus Lamk)," Doctoral Dissertation, Universitas Muhammadiyah Sumatera Utara, Medan, 2018.

[8] W. Hersoelistyorini, S. S. Dewi, and A. C. Kumoro, "Sifat fisikokimia dan organoleptik tepung mocaf dengan fermentasi menggunakan ekstrak kubis," in *Teknologi Kimia dan Industri*, Semarang: LPPM UNIMUS, 2015, pp. 246–256.

[9] D. Purbasari, "Aplikasi metode foam-mat drying dalam pembuatan bubuk susu kedelai instan," *Jurnal Agroteknologi*, vol. 13, no. 1, pp. 52–61, 2019.

[10] M. F. Yana and J. Kusnadi, "Pembuatan yogurt berbasis kacang tunggak (Vigna unguiculata) dengan metode freeze drying (kajian jenis dan konsentrasi bahan pengisi)," *Jurnal Pangan dan Agroindustri*, vol. 3, no. 3, Oct. 2014, [Online]. Available: https://jpa.ub.ac.id/index.php/jpa/article/view/243

[11] Miskiyah, Juniawati, K. Ayu, and A. H. Mulyati, "Study on yoghurt powder probiotic quality using foam-mat drying method," *IOP Conf Ser Earth Environ Sci*, vol. 309, pp. 1–7, Sep. 2019, doi: 10.1088/1755-1315/309/1/012048.

[12] A. Masykur and J. Kusnadi, "Karakteristik kimia dan mikrobiologi yoghurt bubuk kacang tunggak (Vigna Unguiculata L.) metode pengeringan beku (kajian penambahan starter dan desktrin)," *Jurnal Pangan dan Agroindustri*, vol. 3, no. 3, pp. 1171–1179, 2015.

[13] M. Djali, R. Indiarto, and V. Avila, "Kajian penggunaan maltodekstrin pada pembuatan soyghurt bubuk dengan metode pengeringan beku," *Jurnal Penelitian Pangan (Indonesian Journal of Food Research)*, vol. 2, no. 1, Feb. 2018, doi: 10.24198/jp2.2017.vol2.1.02.

[14] M. Djali, H. Marta, and S. Harnah, "Characterics of freeze-dried jack bean yogurt powder with maltodextrin as coating material," *Jurnal Penelitian Pascapanen Pertanian*, vol. 13, no. 1, p. 28, Aug. 2017, doi: 10.21082/jpasca.v13n1.2016.28-35.

[15] U. R. Ernawati, L. U. Khasanah, and R. B. K. Anandito, "Pengaruh variasi nilai Dextrose Equivalents (DE) maltodekstrin terhadap karakteristik mikroenkapsulan pewarna alami daun jati (Tectona Grandis L.F.)," *Jurnal Teknologi Pertanian*, vol. 15, no. 2, pp. 111–120, 2014.

[16] C. E. Endriyani, "Kajian karakteristik fisiko kimia dan sensori mikroenkapsulan ekstrak tempe bosok terstandar sebagai food seasoning dengan variasi rasio enkapsulan gum arab dan maltodekstrin," Undergraduate Thesis, Universitas Sebelas Maret, Surakarta, 2012.

[17] W. Kania, MA. M. Andriani, and Siswanti, "Pengaruh variasi rasio bahan pengikat terhadap karakteristik fisik dan kimia granul minuman fungsional instan kecambah kacang komak (Lablab Purpureus (L.) Sweet)," *Jurnal Teknosains Pangan*, vol. 4, no. 3, pp. 16–29, 2015.

[18] D. M. Sumanti, I. Lanti, I.-I. Hanidah, E. Sukarminah, and A. Giovanni, "Pengaruh konsentrasi susu skim dan maltodekstrin sebagai penyalut terhadap viabilitas dan karakteristik mikroenkapsulasi suspensi bakteri lactobacillus plantarum menggunakan metode freeze drying," *Jurnal Penelitian Pangan (Indonesian Journal of Food Research)*, vol. 1, no. 1, pp. 7–13, Aug. 2016, doi: 10.24198/jp2.2016.vol1.1.02.

[19] M. Masyhura, M. Faudi, and S. Surnaherman, "Aplikasi maltodekstrin pada pembuatan yogurt bubuk biji nangka (arthocarpus lineus)," *Jurnal Teknologi Pertanian Andalas*, vol. 25, no. 1, p. 73, Mar. 2021, doi: 10.25077/jtpa.25.1.73-80.2021.

[20] S. R. Tias, "Kajian karakteristik bumbu kuah bakso bubuk dengan penambahan maltodekstrin menggunakan metode pengeringan vakum ," Universitas Padjadjaran, Bandung, 2013.

[21] Yi Shui Dadi Corn Development, "Certificate of Analysis Maltodextrin.," China, 2015.

[22] M. M Tahir, J. Langkong, A. B. Tawali, N. Abdullah, and S. Surahman, "Study Effect Dryer and Concentration of Maltodextrin to Drink Tea Products–Sappan Wood Effervescent," *Canrea Journal: Food Technology, Nutritions, and Culinary Journal*, vol. *2, no.* 1, pp. 51–61, 2019, https://doi.org/10.20956/canrea.v2i1.192