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EFFECT OF STEVIA ACCESSION (*Stevia Rebaudiana*) AND MALTODEXTRINE CONCENTRATION ON THE PHYSICOCHEMICAL CHARACTERISTICS OF STEVIA POWDER EXTRACT

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Abstract

This research aimed to determine the effect of Stevia accession and the use of maltodextrin concentration on the physicochemical characteristics of Stevia powder extract. The research design used was a Group Randomized Design (GRD) with a 3x3 factorial pattern consisting of 2 (two) factors with 2 (two) replications, so that 18 experimental units were obtained. There is factor B, which is a Stevia accession that consists of 3 levels, namely B1 (BM8), B2 (BP10), and B3 (BP6), and factor M is the concentration of maltodextrin, which consists of 3 levels, namely M1 (10%), M2 (20%), and M3 (30%). The response in this research is the physical response, which includes dissolution time, yield amount, hygroscopicity, and Kamba density. Chemical responses include water content, total sugar content, Stevioside analysis, Rebaudioside-A analysis, and antioxidant levels. Further research consists of Scanning Electron Microscopy EDS (SEM) analysis and Fourier Transform InfraRed (FTIR) analysis.

Keywords: Stevia powder extract, Stevia access, Maltodextrin.

Author Contribution declaration:

Hari Hariadi (analysis of variance of lab and Data, Main Idea, Write)

Muhammad Irfan Fathurrahman (analysis of variance of lab and Data, Write)

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Introduction

Sugar is a food additive made from sugar cane, even though it is only a food ingredient consumption of sugar is done almost every day, so it can be said that the human need for sugar is very high. Apart from being a sweetener, sugar can also provide energy to its consumers. However, excessive sugar consumption often causes various health problems such as obesity and diabetes mellitus. Alternative sweeteners for sugar substitutes expected is a sweetener that is low in calories so safe for long-term consumption by people with people with diabetes and other diseases other diseases. Currently, many sweeteners have been used sugar substitutes that are chemically synthesized, including aspartame, cyclamate, saccharin, and sucralose (Limanto, 2017).

Stevia (*Stevia rebaudiana* R.) is a potential plant that has great potential to be developed as a natural sweetener to replace cane sugar and synthetic sugar. Stevia plants have been used for many years in South American countries and Japan as a natural sweetener. Stevia leaves contain non calories and is capable of producing a sweetness 200 – 300 times higher than cane sugar. the secret to Stevia's sweetness lies in its complex molecule called Stevioside. Stevioside is a glycoside which is composed of glucose, sophorose and steviol. The use of Stevia as a sweetener is safer, non carcinogenic and non-caloric (Saptaji, 2015).

Stevia plants originated in the United States, especially the Paraguay-Brazil-Argentina border used as a mixture of tea or coffee drinks. At Indonesia Stevia has been planted since 1977 in West Java and Central Java (Ratnani, 2005).

Stevia contains antioxidants with different biochemical roles, consisting of ascorbic acid, phenolic compounds, including flavonoids and tannins, phenols, including flavonoids and tannins. Antioxidant activity and prevention of DNA oxidative damage was reported in vitro by methanol and ethyl acetate extracts of Stevia leaves and ethyl acetate extracts of Stevia leaves (Bender, 2015). Stevia leaf also has a low caloric value and has no teratogenic, mutagenic, or carcinogenic effects (Yulianti, 2014).

Stevia leaves that will be processed into an alternative sugar substitute require a drying process to maintain quality and extend shelf life. Furthermore, drying stevia leaves aims to reduce water content, resulting in the highest-quality extract. Research on the development of drying methods continues to be carried out in order to get more effective and efficient results. effective and efficient. Some modern drying methods that have been developed such as drying with spray drying.

A spray dryer is a device for converting liquids into dry powder. The liquid is flowed through a 0.1 mm injector nozzle, then broken down into liquid droplets that come into direct contact with the hot air flow in the drying chamber and cause the water content to evaporate. Then the dry solid particles are separated from the air flow, usually through a cyclone, and collected. Spray drying is the most widely used method in the pharmaceutical and food industries, especially for materials containing flammable phenolic compounds (Chen, 2019). During the drying process, spray drying can protect phenolic compounds and antioxidants better than lyophilization (Assadpour, 2019).

The drying process requires fillers to coat the active compounds contained in food ingredients. Maltodextrin is one such filler that can be used during the drying process. Besides being a filler, maltodextrin is also useful as a coating and can accelerate the drying process. Maltodextrin is a modified starch product that can be used for enzymatic hydrolysis with a DE (dextrose equivalent) of less than 20 (Richana, 2013). Maltodextrin is in the form of white flour, slightly viscous and hygroscopic. hygroscopic, with an almost acceptable flavor, with no or slightly sweet taste. Or slightly sweet. Additives are used in food processing as preservatives and thickeners to increase food intake. Maltodextrin is a thickener that acts as an emulsifier (Suryanto, 2012.).

Materials and methods

The raw materials used in the process of making Stevia powder extract (Stevia Rebaudiana.) are Stevia leaves with codes BP10, BP6, and BM8. The stabilizers used in this study were maltodextrin, chemicals used for analysis in this study were distilled water, filter paper, NaCl solution, double carbon tape, luff schoorl solution, 6N sulfuric acid, KI powder, standard sodium thiosulfate, amylum, 9.5 N HCl, pp indicator, 10 N NaOH, PA methanol, 60% ethanol, 10 Milimolar Na₂HPO₄ pH 2.6, ACN. The tools used in this research are ultrasound assistant extraction brand

LABSONIC FALC, spray dryer brand Buchi, Evaporator brand Buchi, High Performance Liquid Chromatography brand Waters, digital balance, and laboratory glassware. The tools used for analysis in this study are clamps and statives, volumetric flasks, spatulas, stirring rods, desiccators, pipettes, funnels, filter paper, buchner, oven, scales, magnetic stirrer, measuring cup, cup, specimen chamber, holder, blower, Erlenmeyer, water bath, UV-VIS spectrophotometer.

The treatment design in the main research of Stevia powder extract (Stevia rebaudiana.) consists of two factors, namely Stevia accession (B) consisting of 3 levels and maltodextrin concentration (M) consisting of 3 levels, in the following order:

Factor (B), namely Stevia accession, consists of 3 levels, namely:

B1 = Stevia accession sample BM8

B2 = Stevia accession sample BP10

B3 = Stevia accession sample BP6

Factor (M), namely maltodextrin concentration, consists of 3 levels, namely:

M1 = 10%

M2 = 20%

M3 = 30%

The main research procedure was carried out to explain the process of making stevia powder extract and determine the physicochemical characteristics of Stevia powder referring to Martono (2016). Preparation of materials is done by preparing Stevia leaves, and maltodextrin to proceed to the next process, Stevia leaves that have been prepared are sorted which aims to separate leaves that are suitable for processing from leaves that have damage, Drying Stevia leaves using a cabinet dryer with a temperature of 50 ° C and a time of 12 hours. The purpose of drying is to reduce the water content in Stevia leaves and to facilitate the size reduction process, in the size reduction process using a grinder to obtain Stevia with a smaller size, Weighing I is done by weighing the weight of Stevia powder according to the predetermined formulation, Maceration of Stevia powder using Ultra sound-Assisted Extraction bath with a temperature of 40 ° C for 120 minutes using ethanol solvent, Samples that have been extracted with the color of the extraction results are concentrated, filtered. The residue from the filtration was put back into the beaker, added 60% ethanol and extracted again up to 3 times repetition, Stevia liquid extract produced will be evaporated using Vacuum Rotary Evaporator by putting the extract into a series of Vacuum Rotary Evaporator tools with a temperature of 50°C for 180 minutes. This evaporation process aims to obtain the extract. The final result of this process is concentrated Stevia liquid extract, Stevia liquid extract is carried out a mixing process to mix Stevia leaf extract with maltodextrin concentrations, namely, 10%, 20%, 30%. This mixing stage is carried out stirring between Stevia leaf extract and maltodextrin until evenly distributed, Drying is done by drying Stevia liquid extract that has been added to maltodextrin using a spray dryer with a temperature of 120 ° C and a length of time of 120 minutes. This drying aims to reduce the water content contained in the Stevia extract and the final result is obtained in the form of

dried Stevia extract in powder form, The product that has been produced is then analyzed in the form of physical and chemical testing.

The response design that will be carried out in the main research of Stevia powder extract is:

a. Physical responses

The physical responses carried out were testing dissolving time (Widiatmoko and Hartomo, 1993), yield (Tontul and Toyuz, 2017), camba density (Lalel, 2009), hygroscopicity (Ng and Sulaiman, 2017).

b. Chemical responses

The chemical responses were total sugar content analysis using the luff school method (Sudarmadji, 1996), Stevioside analysis using HPLC (Martono, 2016), rebaudioside-A analysis using HPLC (Martono, 2016), moisture content (AOAC, 2005), and antioxidants (Robinson, 1983).

c. Further research

Further research carried out is the analysis of Scanning Electron Microscopy EDS (SEM) (Hoten, 2020), and Fourier Transform Infra Red (FTIR) (Sarifudin, 2021).

Result and discussion

a. Physical responses

– Dissolving

time

Treatments	Averages $\pm$ Standard Deviations
B1M1	2,42 $\pm$ 0,02 ^e
B1M2	2,31 $\pm$ 0,01 ^b
B1M3	2,24 $\pm$ 0,01
B2M1	2,39 $\pm$ 0,01 ^a
B2M2	2,33 $\pm$ 0,03 ^c
B2M3	2,26 $\pm$ 0,04 ^a
B3M1	2,76 $\pm$ 0,02 ^g
B3M2	2,52 $\pm$ 0,02 ^f
B3M3	2,34 $\pm$ 0,01 ^c

Table 1. Dissolving Time Analysis Result

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Based on the results of ANOVA calculations in the appendix, it is known that the factors of Stevia Accession (B) and Maltodextrin Concentration (M) had a real effect on dissolving time. Stevia accessions cause the steviol glycosides contained in Stevia samples are different. Stevia accessions with different steviol glycoside content can be a factor that determining the dissolving time (Mahajan, 2022). According to Djali (2016) explains that the addition of fillers can affect the dissolving time. Filler material in the form of maltodextrin has the property of dissolving easily in water so that if a material is added maltodextrin so if a material is added maltodextrin, it can accelerate the dissolving time. can speed up the dissolving time. In addition, the addition of fillers can increase the total solids of powdered materials such as oligosaccharides, proteins, and fats that will be degraded into simpler compounds. will be degraded into simpler compounds where the molecular weight is lower than before thus accelerating the dissolving time.

– Yield

Table 2. Yield Analysis Results

Treatments	Averages $\pm$ Standard Deviations
B1M1	8,69 $\pm$ 0,07 ^b
B1M2	18,885 $\pm$ 0,05 ^e
B1M3	30,15 $\pm$ 0,06 ^h
B2M1	9,85 $\pm$ 0,04 ^c
B2M2	15,785 $\pm$ 0,04 ^d
B2M3	29,44 $\pm$ 0,06 ^g
B3M1	7,755 $\pm$ 0,05 ^a
B3M2	19,085 $\pm$ 0,05 ^f
B3M3	31,325 $\pm$ 0,05 ⁱ

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Based on the results of ANOVA calculations in the appendix, it is known that the factors of Stevia Accession (B) and Maltodextrin Concentration (M) had a real effect on yield. Stevia that has been accessioned will get different levels of steviol glycosides, due to cultivation conditions such as climate, soil, and fertilization. These cultivation conditions can affect the level of yield obtained (Amarakoon, 2021). The extraction method used and processing conditions can also affect the yield obtained. The results show that maltodextrin concentration can affect yield. The higher the concentration of maltodextrin added, the higher the yield. This is because maltodextrin functions to increase the total solids content of the material,

and one of the functions of maltodextrin is to increase the volume of the product. the higher and one of the functions of maltodextrin as a filler material that can increase yield of the final product (Nugroho, 2006).

– Camba density

Table 3. Camba Density Analysis Results

Stevia accessions	Camba Density Level (g/mL)	Significant level (5%)
B3 (BP6)	0,165	a
B1 (BM8)	0,168	a
B2(BP10)	0,174	b

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Table 4. Camba Density Analysis Results

Maltodextrin Concentration	Camba Density Level (g/mL)	Significant level (5%)
M1 (10%)	0,19	a
M2 (20%)	0,17	b
M3 (30%)	0,15	c

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Based on the results of ANOVA calculations in the appendix, it is known that the factors of Stevia Accession (B) and Maltodextrin Concentration (M) had a significant effect on each factor and did not interact with each other. to each factor and did not interact on the analysis of camba density. The size of a product particle affects on the value of slurry density, with the smaller the the smaller the particle size, the decreases. A large cubage density value is very expected in powder products because the narrow space between molecules will increase the cohesiveness cohesiveness of the particles so that there is an inhibition in the entry of water vapor which will increase the chance of of clumping and product deterioration (Stranzinger, 2019). The addition of maltodextrin can affect the camba density of Stevia powder extracts by decreasing density, increasing porosity, and changing flow properties (Hartati, 2023). Lowering density, maltodextrin has a lower density than Stevia. lower than Stevia, so its addition will lower the overall density of Stevia powder extract. Increase porosity, maltodextrin can increase the porosity of the extract extracts, which can also lower the density of the cages. And change the flow properties, maltodextrin can make Stevia powder easier to flow, which can affect the way Stevia powder extract is packaged and measured, so it can affect the measured density value measured.

– Hygroscopicity

Table 5. Hygroscopicity Analysis Results

Treatments	Averages $\pm$ Standard Deviations
B1M1	4,57 $\pm$ 0,01 ^f
B1M2	4,43 $\pm$ 0,04 ^e
B1M3	4,40 $\pm$ 0,04 ^{de}
B2M1	4,46 $\pm$ 0,01 ^e
B2M2	4,29 $\pm$ 0,01 ^c
B2M3	4,00 $\pm$ 0,01 ^a
B3M1	4,54 $\pm$ 0,02 ^f
B3M2	4,35 $\pm$ 0,01 ^d
B3M3	4,19 $\pm$ 0,02 ^b

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Based on the results of ANOVA calculations in the appendix, it is known that the factors of Stevia Accession (B) and Maltodextrin concentration (M) had a significant effect on hygroscopicity. Stevia as a natural sweetener, has low hygroscopic properties. This means that Stevia does not easily attract water from the surrounding environment. This can cause products containing Stevia to have low hygroscopicity, The content and structure of steviol glycosides are also a factor in the level of hygroscopicity (Mahajan, 2024). The higher addition of maltodextrin can cause bonds between ingredients and encapsulant stronger, so that it can reduce the absorption of water to the material. This can be interpreted that maltodextrin is able to reduce the ability of Stevia powder extract to absorb water in the environment.

b. Chemical responses

– Moisture content

Table 6. Moisture content Analysis Results

Treatments	Averages $\pm$ Standard Deviation
B1M1	5,39 $\pm$ 0,06 ^c
B1M2	5,35 $\pm$ 0,07 ^c
B1M3	5,24 $\pm$ 0,05 ^{ab}
B2M1	5,685 $\pm$ 0,01 ^{ef}
B2M2	5,535 $\pm$ 0,02 ^d
B2M3	5,225 $\pm$ 0,04 ^a
B3M1	5,825 $\pm$ 0,04 ^f
B3M2	5,625 $\pm$ 0,04 ^{de}

Treatments	Averages ± Standard Deviation
B3M3	5,325 ± 0,04 ^{bc}

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Based on the results of ANOVA calculations in the appendix, it is known that the factors of Stevia Accession (B) and Maltodextrin Concentration (M) had a real effect on moisture content. Stevia cell structure can vary between accessions of Stevia. Stevia accessions with thicker and tighter cell walls generally have a higher water-holding capacity, resulting in higher moisture content. Cultivation conditions, harvesting methods, and processing are also factors that affect moisture content (Amarakoon, 2021). According to Hui (2002), the addition of more maltodextrin affects the water content so that it decreases. Thus the addition of maltodextrin decreases the binding power (interaction) of the mixture of ingredients with water, so that it will more easily evaporate during the heating process.

– Total sugar content

Table 7. Total sugar content Analysis Results

Treatments	Averages ± Standard Deviation
B1M1	9,29 ± 0,18 ^a
B1M2	15,18 ± 0,13 ^c
B1M3	21,35 ± 0,30 ^e
B2M1	9,16 ± 0,21 ^a
B2M2	17,01 ± 0,16 ^d
B2M3	22,34 ± 0,27 ^f
B3M1	9,55 ± 0,40 ^b
B3M2	15,41 ± 0,15 ^c
B3M3	23,36 ± 0,36 ^f

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Based on the results of ANOVA calculations in the appendix, it is known that the factors of Stevia Accession (B) and Maltodextrin concentration (M) had a significant effect on total sugar content. Maltodextrin as an encapsulator can contribute to the total sugar of the product. The DE value of maltodextrin indicates the reducing sugars that are contained, for example in the Stevia powder research powder research used maltodextrin DE of 10-12%, thus contains 11% reducing sugar (BSN, 2010). In line with the statement of Rosida (2021). maltodextrin is an incompletely hydrolyzed starch compound composed of a mixture of simple sugars (mono and disaccharides) in small small amounts, large amounts of short-chain oligosaccharides and long-chain oligosaccharides. Basically, maltodextrin consists of sugars in simple form, which can lead to an increase in the total amount of sugar

in the product. The more maltodextrin is added, the more sugar is mixed in. The total sugar produced in the product can be related to the reducing sugars derived from the fruit and the calculated organic acids (Indriaty, 2015). In Hastuti's research (2014), the total sugar content of Stevia leaves was 5.27%.

– Stevioside content

Table 8. Stevioside content Analysis Results

Treatments	Averages ± Standard Deviation
B1M1	0,22 ± 0,01 ^a
B1M2	0,49 ± 0,03 ^{ab}
B1M3	0,68 ± 0,07 ^{bc}
B2M1	0,94 ± 0,01 ^{de}
B2M2	1,04 ± 0,20 ^e
B2M3	1,40 ± 0,04 ^f
B3M1	0,71 ± 0,06 ^{cd}
B3M2	1,06 ± 0,11 ^e
B3M3	1,41 ± 0,11 ^f

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Based on the results of ANOVA calculations in the appendix, it is known that the factors of Stevia Accession (B) and Maltodextrin Concentration (M) had a real effect on Stevioside content. The interaction between Stevia accession and maltodextrin concentration affected the stevioside content. Maltodextrin can affect the stevioside levels in Stevia powder extract because maltodextrin has a function that can increase the stability that acts as a stabilizing agent, helps prevent stevioside from clumping and increase its heat resistance. Maltodextrin can increase solubility which helps stevioside dissolve more easily in water, making it easier to used in various applications. And maltodextrin can increase flowability (Nuraini, 2016). Different levels of Stevioside can be influenced by the dispersion of the material when dissolved. Factors that affect extraction results include the size of the material, extraction time, extraction temperature, type and amount of solvent. Physical events that occur in extraction process is mass transfer. This mass transfer occurs due to the difference in concentration from high concentration to a lower concentration (Treybal, 1981).

– Rebaudioside content

Table 9. Rebaudioside content Analysis Results

Treatments	Averages ± Standard Deviation
B1M1	5,39 ± 0,06 ^c

B1M2	5,35 ± 0,07 ^c
B1M3	5,24 ± 0,05 ^{ab}
B2M1	5,685 ± 0,01 ^{ef}
B2M2	5,535 ± 0,02 ^d
B2M3	5,225 ± 0,04 ^a
B3M1	5,825 ± 0,04 ^f
B3M2	5,625 ± 0,04 ^{de}
B3M3	5,325 ± 0,04 ^{bc}

Note: Different letter in each column indicates a significant difference ($p < 0.05$).

Based on the results of ANOVA calculations in the appendix, it is known that the factors of Stevia Accession (B) and Maltodextrin Concentration (M) had a real effect on Rebaudioside content. Maltodextrin plays a role in protecting the compounds that are already contained during maceration. The result of the extract is the result of the solvent's work in dissolving Rebaudioside-A contained in Stevia leaves, either directly or by diffusion. Increased yield of extract is in line with the theory which states that the length of extraction affects the weight and percentage of Rebaudioside-A obtained, namely the longer the extraction, the weight and percentage of Rebaudioside A will increase (Dewi, 2008). Factors that influence ultrasonic wave-assisted extraction ultrasonic waves are temperature, time, and concentration of the solvent used. In the preparation of Stevia powder is made using ultrasonic at a temperature of 40°C, with a time of 15 minutes and using 60% alcohol. 60%. The extraction of active compounds or metabolites from natural materials is influenced by many factors, such as internal factors related to genetics including genes and enzyme activity and external factors, namely environment including light, temperature, water, sampling location, and sample type (Li, 2020).

– Antioxidant content

Table 10. Antioxidant content Analysis Results

Sample Type	Antioxidant Activity Value in IC ₅₀ (ppm)
Stevia Powder Extract code B3M3	1570,085

Antioxidant Activity Analysis only using selected samples only. Samples were selected based on the results of the highest Stevioside content analysis. The sample with the highest stevioside content was found to be sample B3M3 (BP6) with stevioside content of 1,41 mg/L. High levels of stevioside depict high tannin levels. Tannins are compounds of polyphenol compounds that have strong antioxidant properties. The higher the extracted stevioside, the higher the tannin content (Wahyuni, 2016). According to Dewi (2016), states that antioxidant activity will

decrease due to high drying temperature. This is because the high heating temperature will cause secondary metabolite compounds that can act as antioxidants (carotene) become damaged. Based on the antioxidant results obtained less active but potential, caused by the process of processing of the material too long in contact with oxygen, heat and light. In research conducted by Kurniati (2019), heating temperature causes differences in antioxidant activity of noni extract. differences in antioxidant activity of noni extract. The temperature that can be used to maintain antioxidant activity of a material is 60° C, the higher temperature, the lower the antioxidant content obtained. Overheating can cause decomposition of bioactive compounds contained in the ingredients contained there in.

c. Further research

Further research aims to find out more about morphology and identifying the functional groups contained in the Stevia extract powder extract. This stage of research uses Scanning Electron Microscope (SEM) and Fourier Transform Infrared Spectroscopy (FTIR).

– Scanning Electron Microscope (SEM)

- Sample BP10, Concentration 10%

Figure 1. SEM Test Results Sample BP10, 10% maltodextrin concentration, 5,000x magnification.

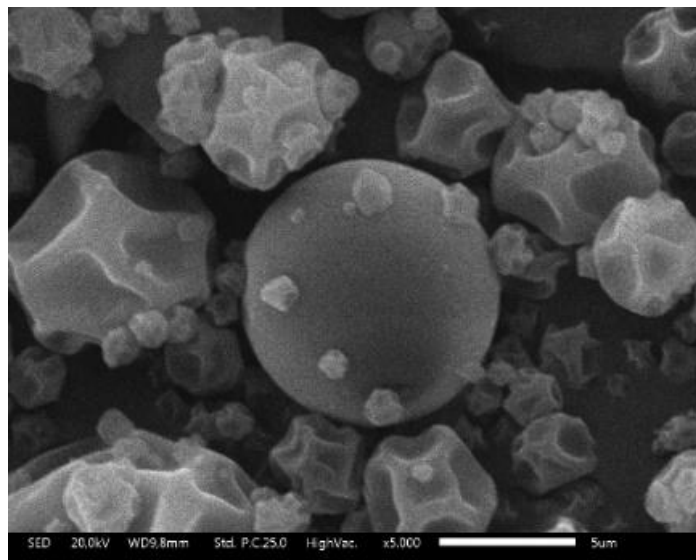
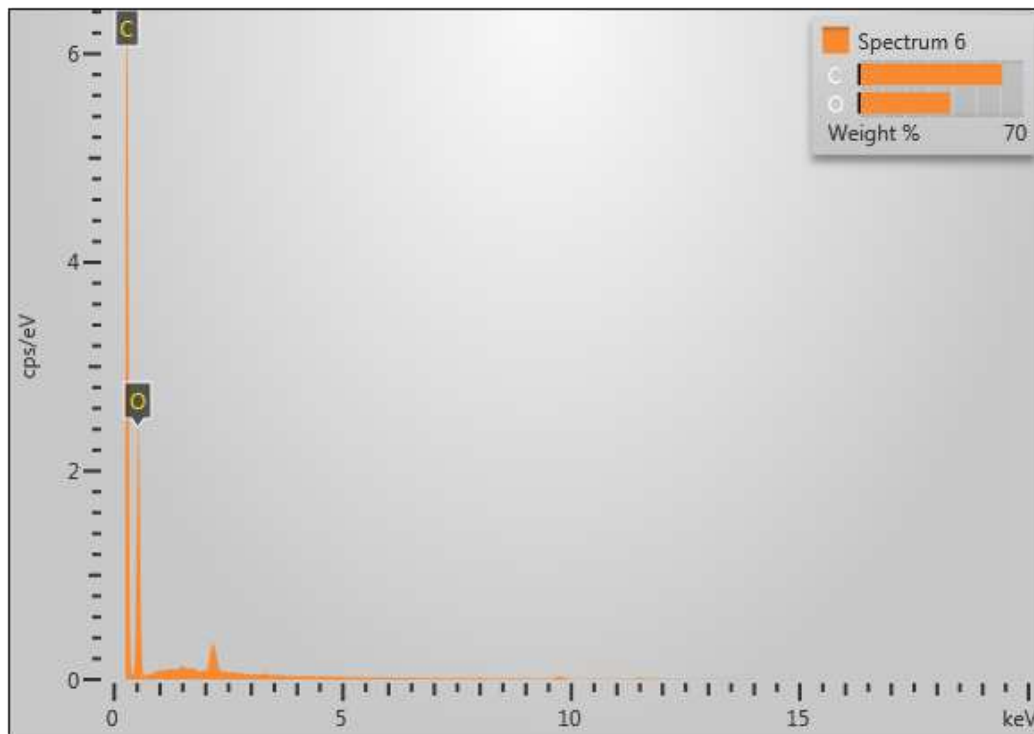


Figure 2. EDS results of sample BP10, 10% maltodextrin concentration.



The results of SEM EDS images of particles that are formed unevenly, amorphous, round, indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm , particle size at a resolution of 1536 pixels has a height of 9.93 μm . At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. It can be seen that the constituent elements of Stevia powder from BP 10 leaf type with 10% maltodextrin concentration are C (67.61%) and O (32.39%).

- Sample BP 10, Concentration 20%

Figure 3. SEM Test Results Sample BP10, 20% maltodextrin concentration, 5,000x magnification.

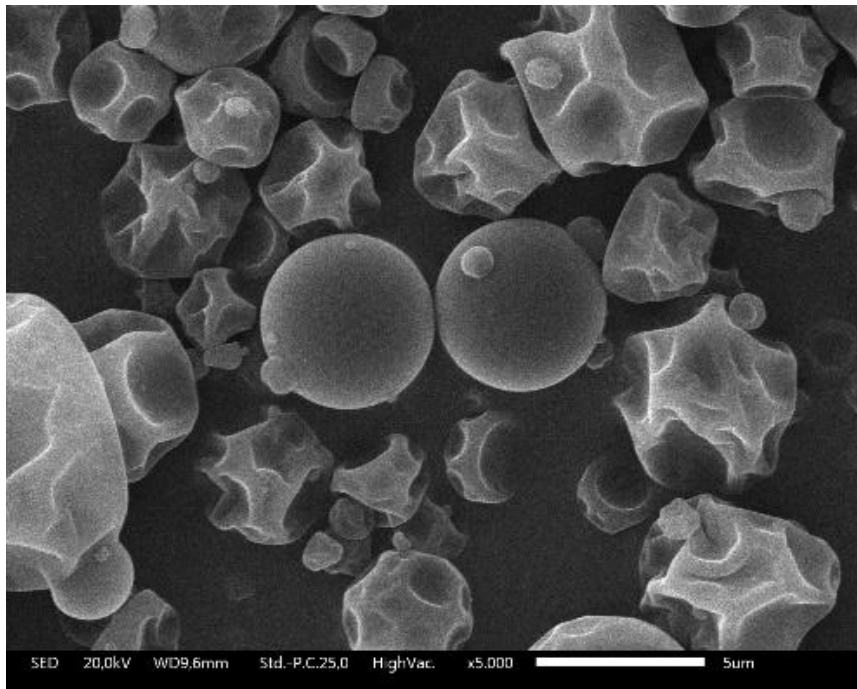
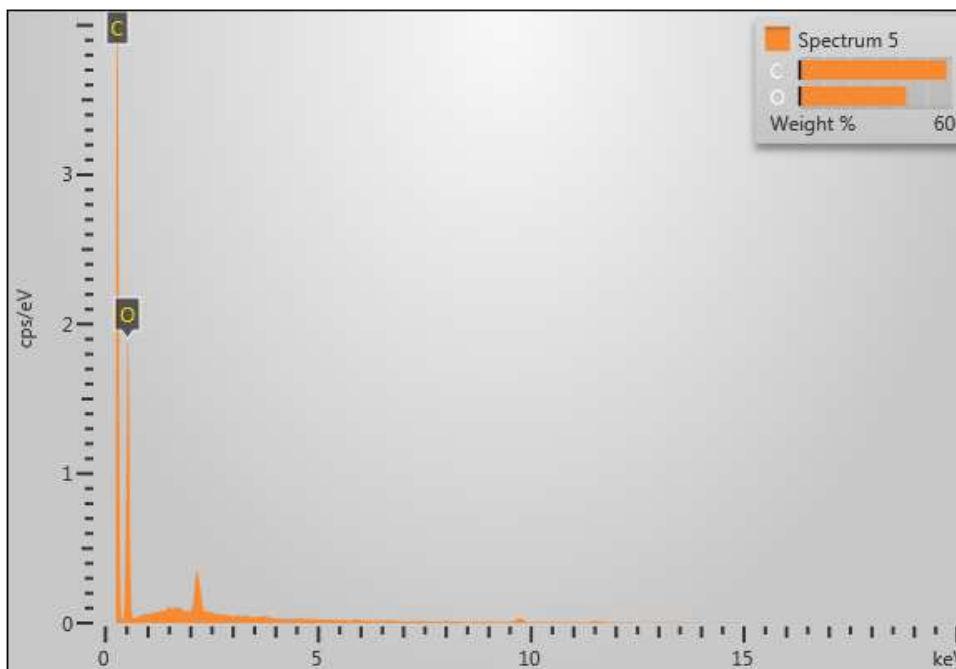


Figure 4. EDS results of sample BP10, 20% maltodextrin concentration.



The results of SEM images of particles that are formed unevenly, amorphous, round, indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm , particle size at a resolution of 1536 pixels has a height of 9.93 μm . At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. By using EDS (Energy Dispersive X-Ray Spectroscopy), it can be seen that the

constituent elements of Stevia powder from BP 10 leaf type with 20% maltodextrin concentration are C (64.66%) and O (35.34%).

- Sample BP 10, Concentration 30%

Figure 5. SEM Test Results Sample BP10, 30% maltodextrin concentration, 5,000x magnification.

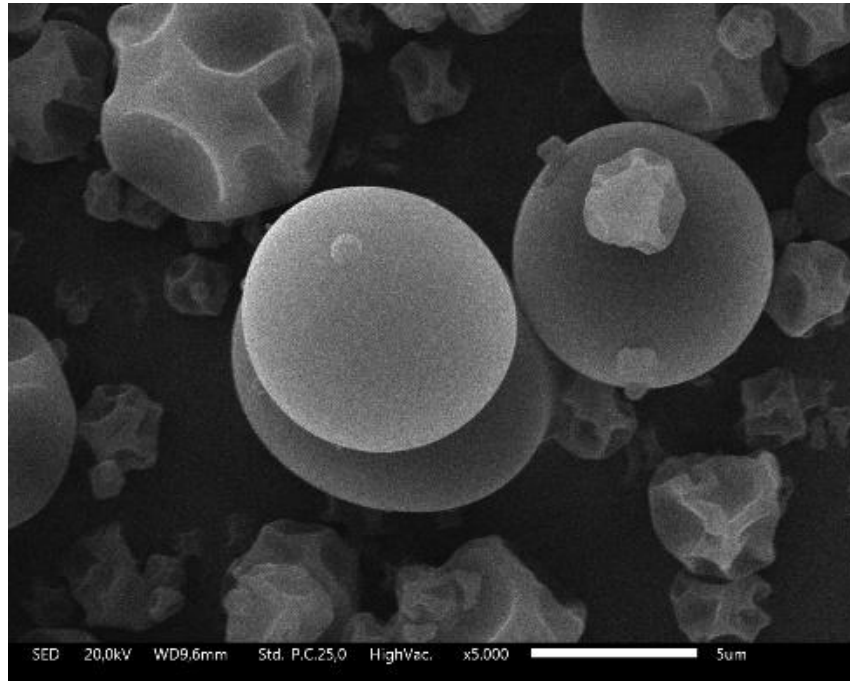
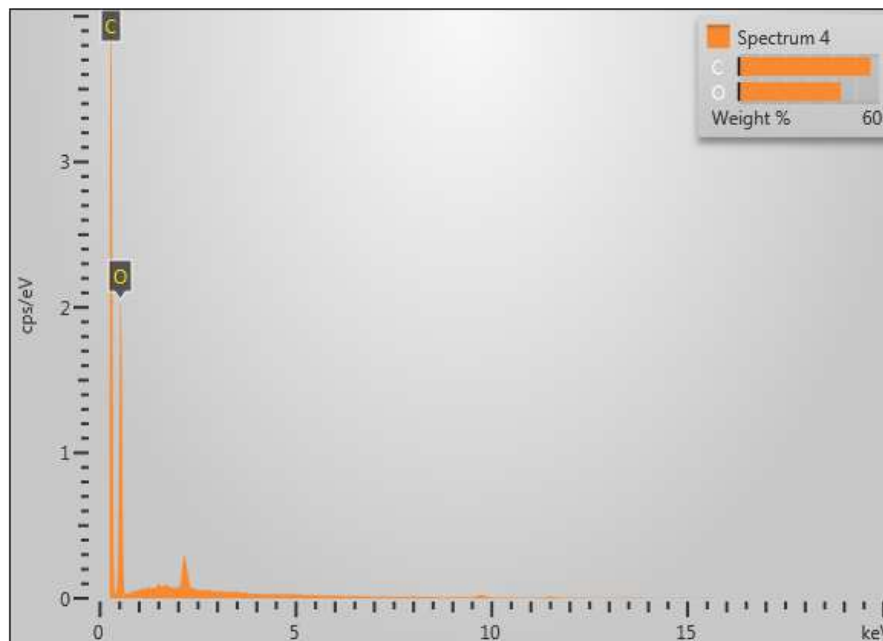


Figure 6. EDS results of sample BP10, 30% maltodextrin concentration.



The results of SEM images of particles that are formed unevenly, amorphous, round, indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm , particle size at a resolution of 1536 pixels has a height of 9.93 μm . At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. By using EDS (Energy Dispersive X-Ray Spectroscopy) it can be seen that the constituent elements of Stevia powder from BP 10 leaf type with 30% maltodextrin concentration are C (63.19%) and O (36.81%).

Based on the SEM results on the type of BP10 leaves with variations in the addition of maltodextrin concentration, it can be concluded that there are 2 types of particles formed, namely uneven particles and perfectly round particles, this is because the trajectory passed by the particles is not always straight, and tends to be random. Random droplet trajectories can cause collisions or collisions both between droplets and the walls of the drying chamber and between droplets and other droplets, this is what causes the shape of the particles to be uneven. The probability of such collisions will be more massive if the volume of the chamber is smaller, the angle of the burst is wider, and the feed flow rate is greater (Alwan, 2019).

The constituent elements in BP 10 leaf type are carbon (C) and oxygen (O). The addition of maltodextrin concentration of 10% to 30% causes a decrease in the carbon (C) element content, while the oxygen (O) element increases, this is due to the presence of functional groups containing oxygen in the energy storage process, the redox reaction between certain functional groups containing oxygen with electrolyte ions is very efficient and reversible, and functional groups containing oxygen have shown their own advantages in improving the surface properties of carbon materials and increasing density, but the addition of functional groups containing oxygen is often accompanied by a decrease in the conductivity of carbon materials (Qiu, 2023).

Sample BP6, Concentration 10%

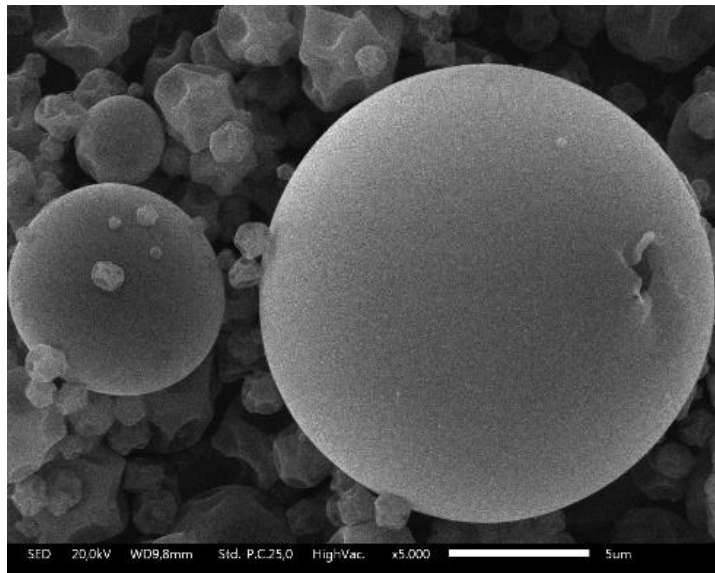
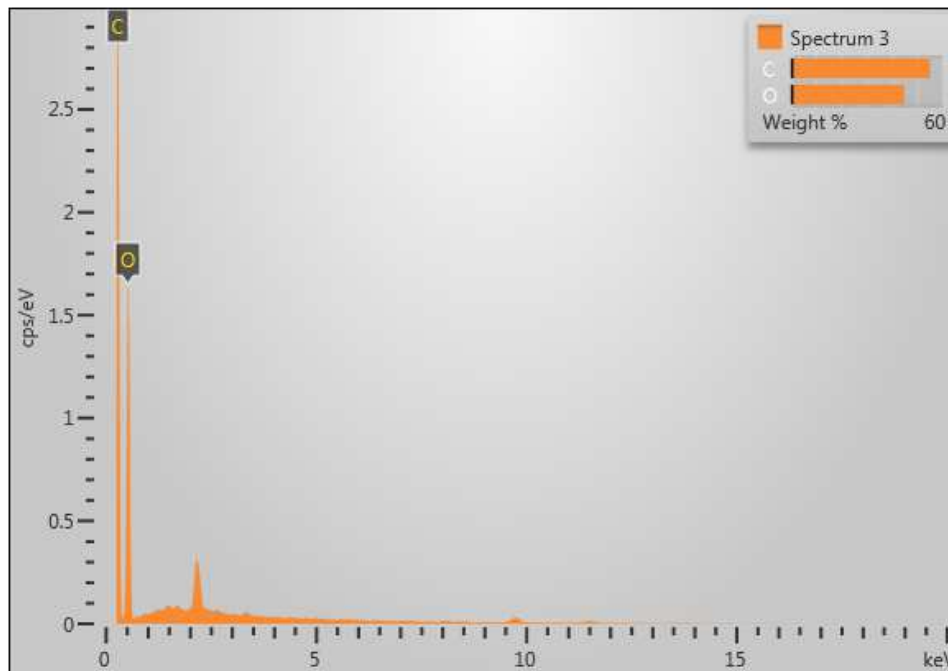


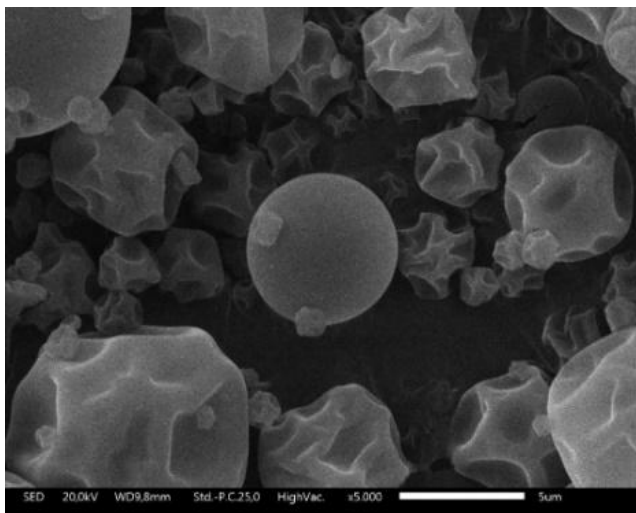
Figure 7. SEM Test Results Sample BP6, 10% maltodextrin concentration, 5,000x magnification.

Figure 8. EDS results of sample BP6, 10% maltodextrin concentration.



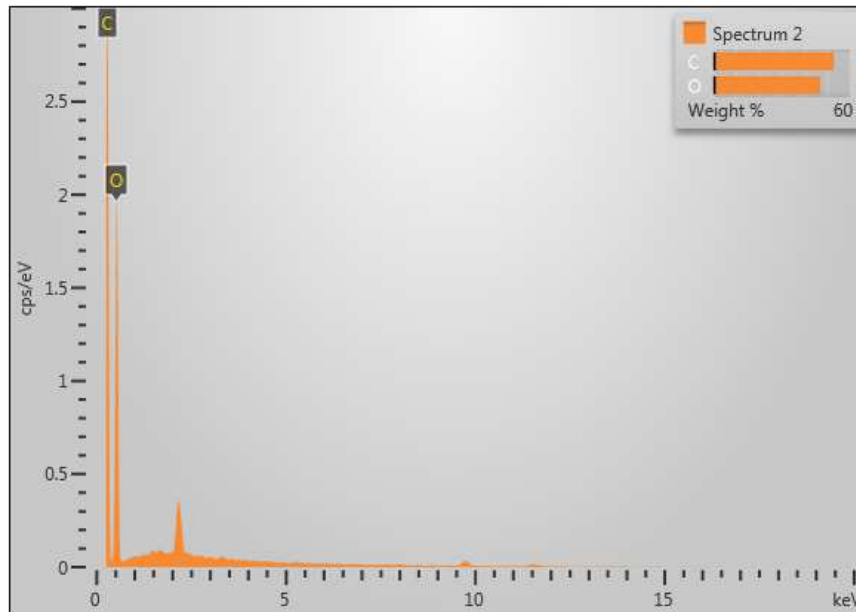
The results of SEM images of particles that are formed unevenly, amorphous, round, indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm , particle size at a resolution of 1536 pixels has a height of 9.93 μm . At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. By using EDS (Energy Dispersive X-Ray Spectroscopy), it can be seen that the constituent elements of Stevia powder from BP 6 leaf type with 10% maltodextrin concentration are C (62.06%) and O (37.94%).

- Sample BP6, Concentration 20%



- Figure 9. SEM Test Results Sample BP6, 20% maltodextrin concentration, 5,000x magnification.

Figure 10. EDS results of sample BP6, 20% maltodextrin concentration.



The results of SEM images of particles that are formed unevenly, amorphous, round, indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm , particle size at a resolution of 1536 pixels has a height of 9.93 μm . At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. By using EDS (Energy Dispersive X-Ray Spectroscopy) it can be seen that the constituent elements of Stevia powder of leaf type BP 6 with 20% maltodextrin concentration are C (59.97%) and O (40.03%).

- Sample BP6, Concentration 30%

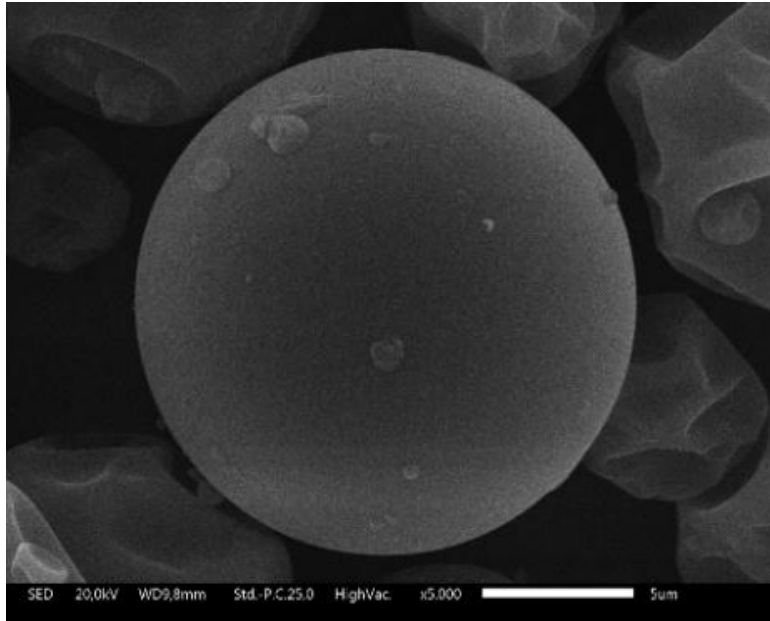
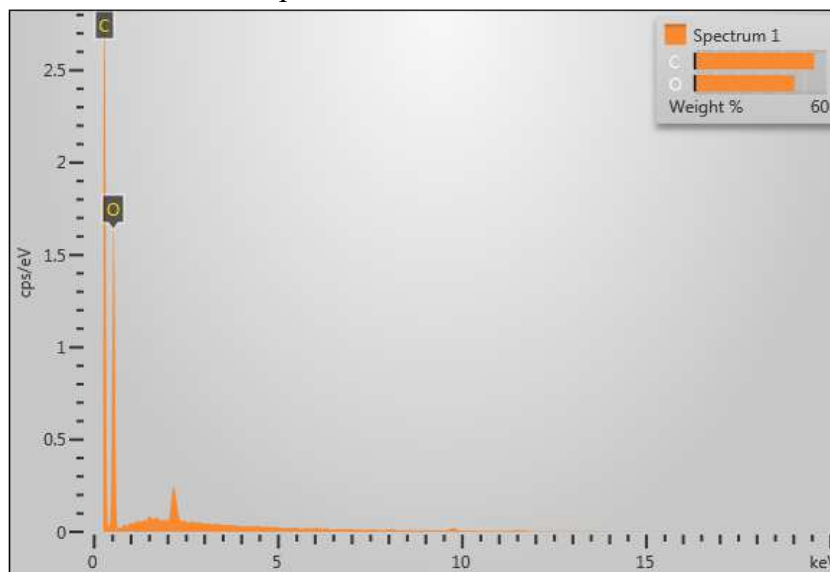


Figure 11. SEM Test Results Sample BP6, 30% maltodextrin concentration, 5,000x magnification.

Figure 12. EDS results of sample BP6, 30% maltodextrin concentration.



The results of SEM images of particles that are formed unevenly, amorphous, round, indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm , particle size at a resolution of 1536 pixels has a height of 9.93 μm . At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. By using EDS (Energy Dispersive X-Ray Spectroscopy), it can be seen that the constituent elements of Stevia powder from BP 6 leaf type with 30% maltodextrin concentration are C (57.88%) and O (42.12%).

- Sample BM8, Concentration 10%

Figure 14. SEM Test Results Sample BM8, 10% maltodextrin concentration, 5,000x magnification.

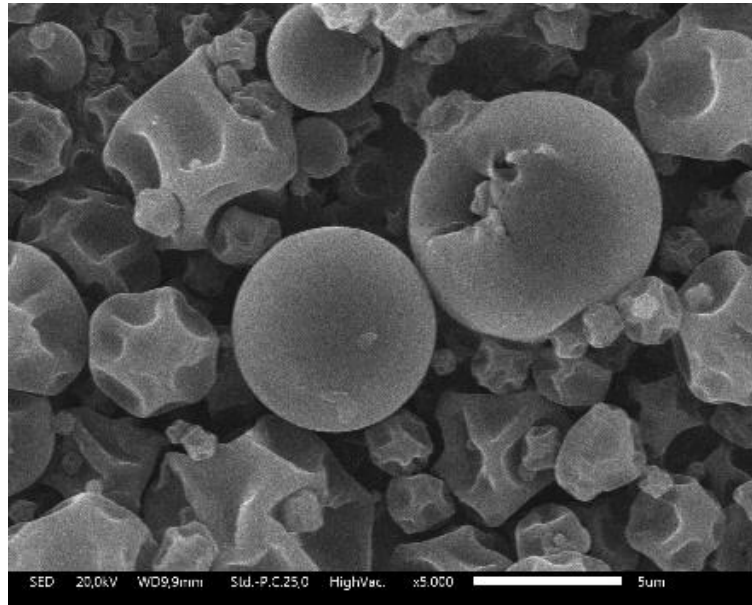
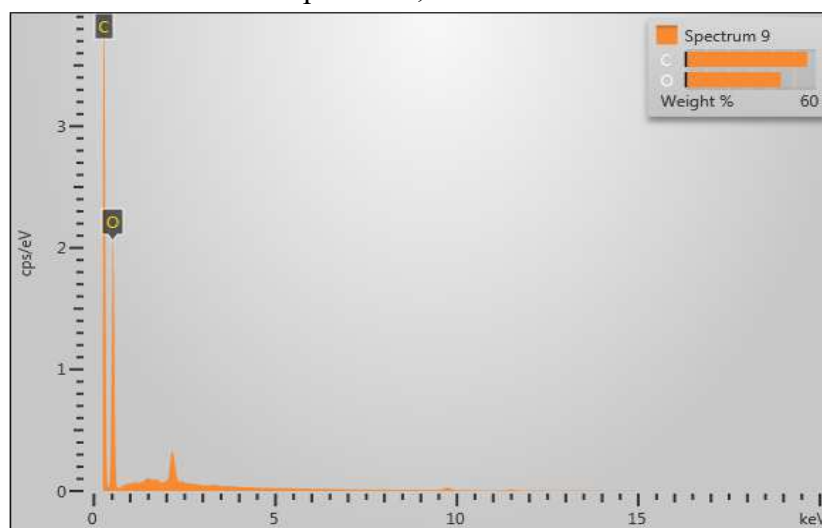


Figure 15. EDS results of sample BM8, 10% maltodextrin concentration.



The results of SEM images of particles that are formed unevenly, amorphous, round, indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm, particle size at a resolution of 1536 pixels has a height of 9.93 μm. At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. By using EDS (Energy Dispersive X-Ray Spectroscopy) it can be seen that the constituent elements of Stevia powder from BM8 leaf type with 30% maltodextrin concentration are C (62.31%) and O (37.69%).

- Sample BM8, Concentration 20%

Figure 16. SEM Test Results Sample BM8, 20% maltodextrin concentration, 5,000x magnification.

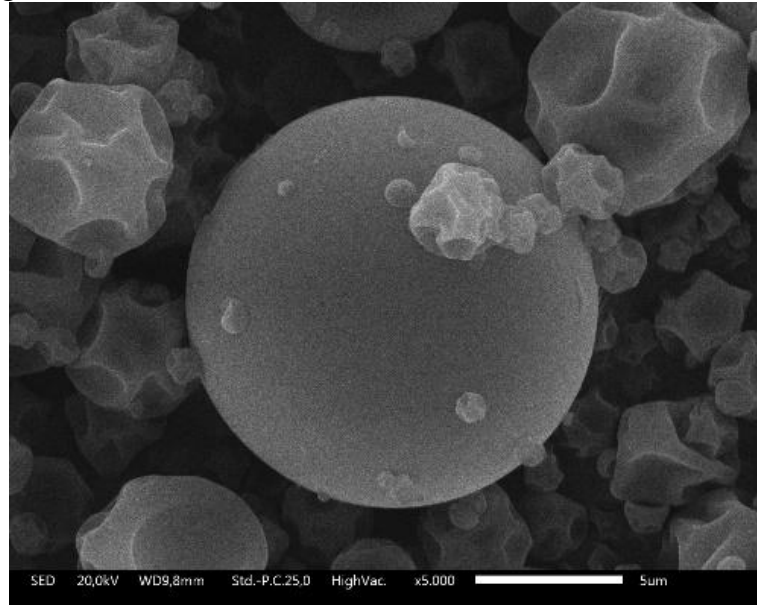
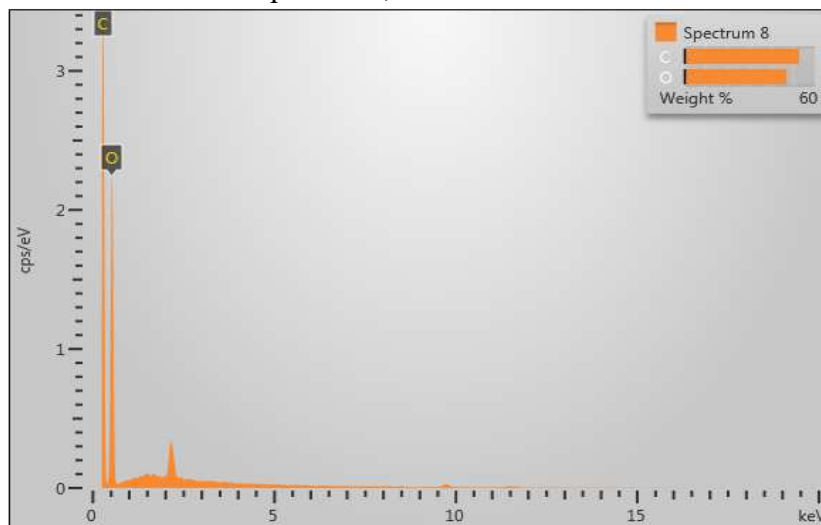


Figure 17. EDS results of sample BM8, 20% maltodextrin concentration.



The results of SEM images of particles that are formed unevenly, amorphous, round, indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm , particle size at a resolution of 1536 pixels has a height of 9.93 μm . At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. By using EDS (Energy Dispersive X-Ray Spectroscopy) it can be seen that the constituent elements of Stevia powder from BM8 leaf type with 30% maltodextrin concentration are C (62.31%) and O (37.69%).

- Sample BM8, Concentration 30%

Figure 18. SEM Test Results Sample BM8, 30% maltodextrin concentration, 5,000x magnification

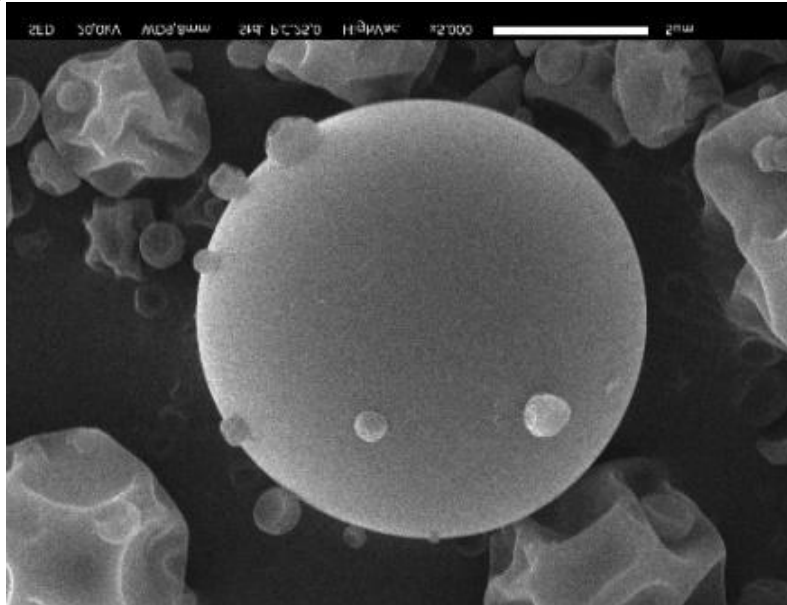
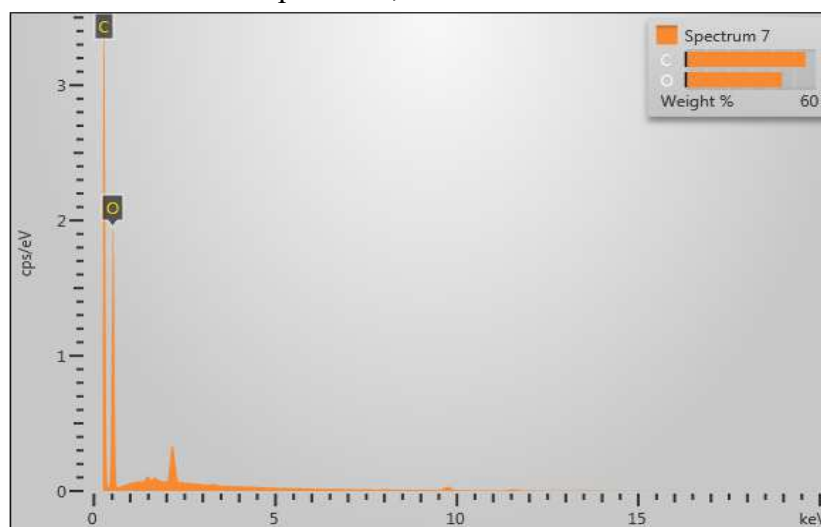


Figure 19. EDS results of sample BM8, 30% maltodextrin concentration



The results of SEM images on particles that are formed unevenly, amorphous in shape, round indented, particle size at a wide resolution of 2048 pixels has a width of 13.2 μm , particle size at a resolution of 1536 pixels has a height of 9.93 μm . At 5000x magnification, it can be seen that the particles are round, smooth, and not notched. By using EDS (Energy Dispersive X-Ray Spectroscopy) it can be seen that the constituent elements of Stevia powder from BM8 leaf type with 30% maltodextrin concentration are C (59.90%) and O (40.10%).

- Fourier Transform Infra Red (FTIR)
- Sample BP10

Figure 20. FTIR results of BP10, 10% maltodextrin concentration

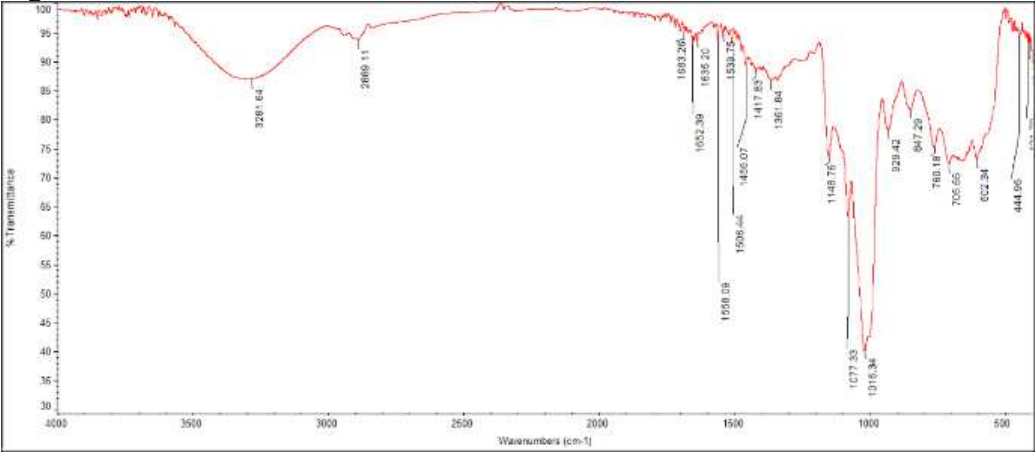


Figure 21. FTIR results of BP10, 20% maltodextrin concentration

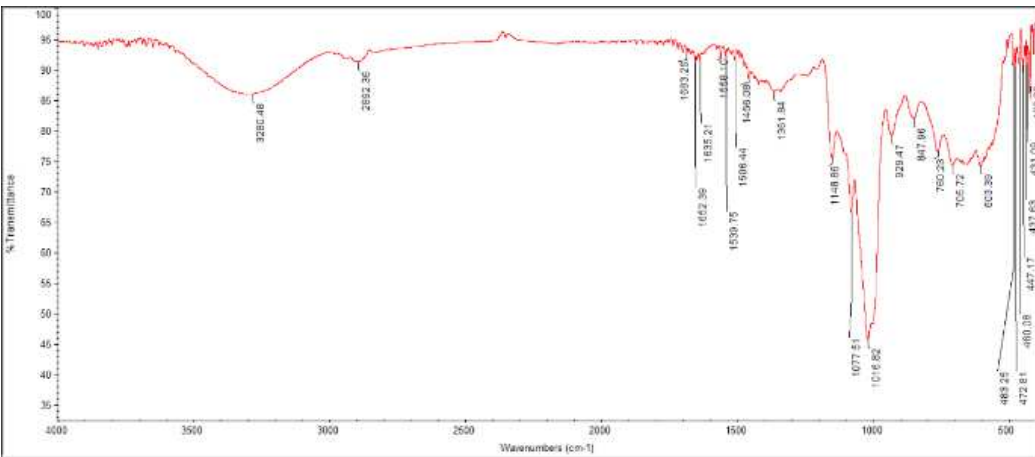
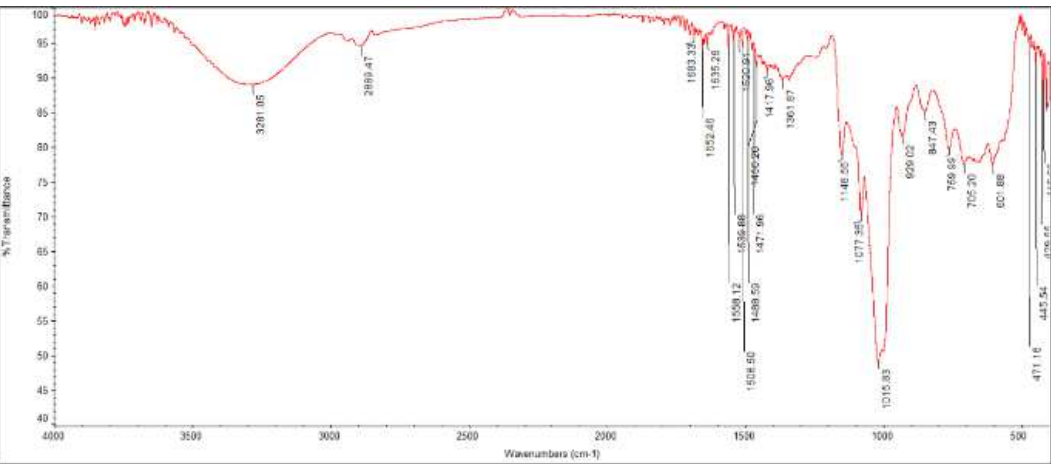


Figure 22. FTIR results of BP10, 10% maltodextrin concentration



Based on the results of infrared spectra, hydrogen bond alcohol groups were found in the type of BP 10 leaves with variations in the addition of maltodextrin successively at 3281.64 cm⁻¹, 3280.48 cm⁻¹, and 3281.05 cm⁻¹ characterized by a widened absorption area of (O-H) bonds with strong intensity in alcohol groups. The C-H alkane group in the infrared spectra of Stevia powder BP 10 leaf type is shown in the peaks of 2889.11 cm⁻¹, 2892.36 cm⁻¹, 2899.35 cm⁻¹ which is characterized by the stretching vibration of the C-H bond with strong intensity in the alkane group. The C=C alkene group is shown at peak 1683.26 cm⁻¹, 1683.26 cm⁻¹, and 1683.33 cm⁻¹ which is characterized by the stretching vibration of the C=C bond with strong intensity in the alkene group. According to Tambe's research (2010), standard Stevioside contains carboxylic acids at a wavelength of 1011.48, in sample BP 10 there are at wavelengths of 1016.34 cm⁻¹, 1016.82 cm⁻¹, and 1015.83 cm⁻¹, respectively. (Nandiyanto, 2019).

- Sample BP6

Figure 23. FTIR results of BP6, 10% maltodextrin concentration

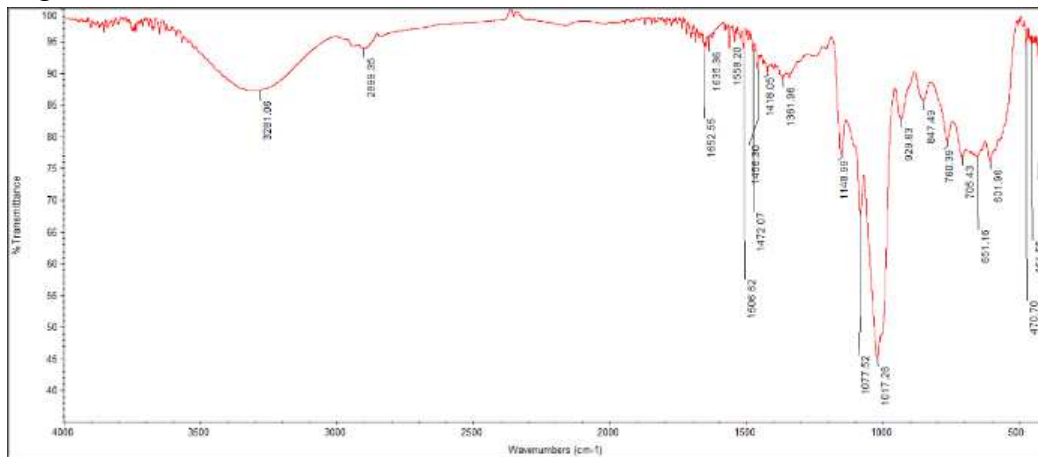


Figure 24. FTIR results of BP6, 20% maltodextrin concentration

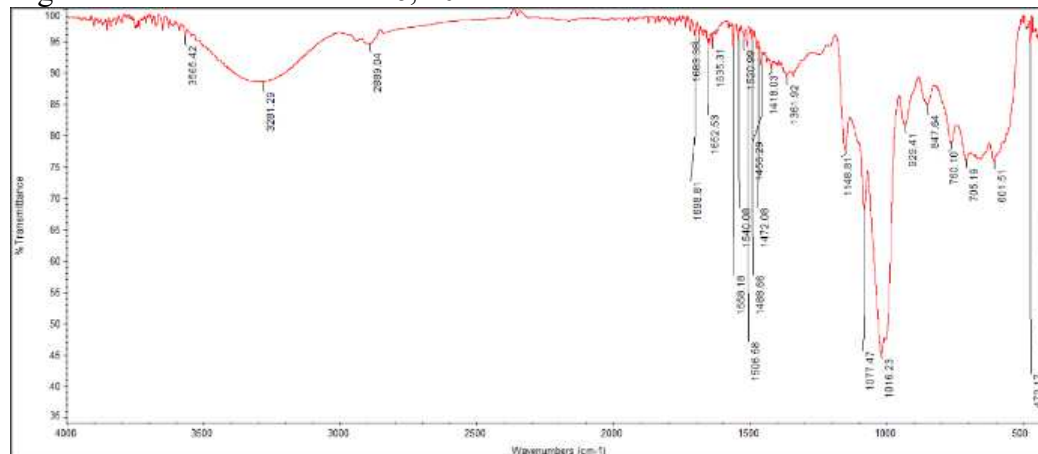
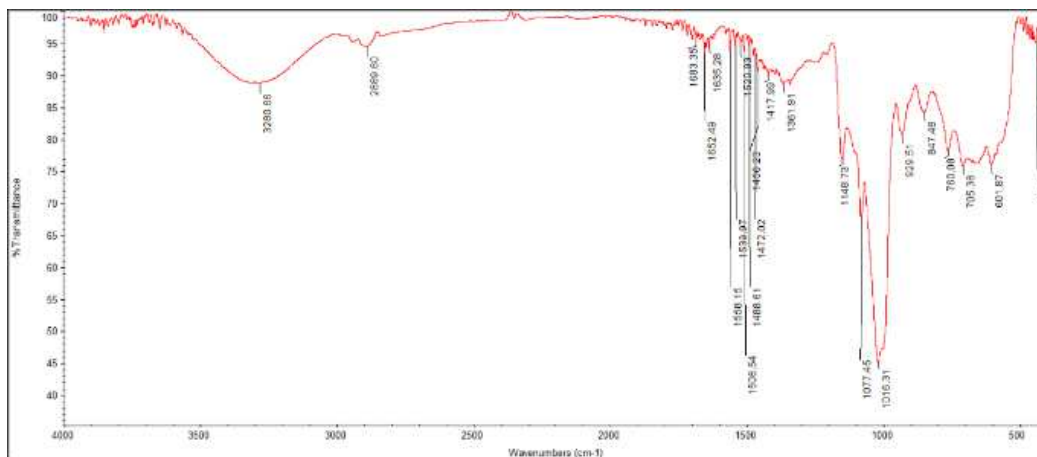


Figure 25. FTIR results of BP6, 30% maltodextrin concentration



Based on the results of infrared spectra, the hydrogen bond alcohol group was found in the BP 6 leaf type with variations in maltodextrin addition successively at 3281.06 cm⁻¹, 3281.29 cm⁻¹, and 3280.66 cm⁻¹ characterized by a widened absorption area of the (O-H) bond with a strong intensity in the alcohol group. The C-H alkane group in the infrared spectra of Stevia powder BP 6 leaf type is shown in the peaks of 2899.35 cm⁻¹, 2889.04 cm⁻¹, 2889.60 cm⁻¹ which is characterized by the stretching vibration of the C-H bond with strong intensity in the alkane group. The C=C alkene group is shown at peak 1652.55 cm⁻¹, 1652.53 cm⁻¹, and 1652.49 cm⁻¹ which is characterized by the stretching vibration of the C=C bond with strong intensity in the alkene group. According to Tambe's research (2010), standard Stevioside contains carboxylic acids at a wavelength of 1011.48, in sample BP 6 there are at wavelengths of 1017.26 cm⁻¹, 1016.23 cm⁻¹, and 1016.31 cm⁻¹, respectively. (Nandiyanto, 2019).

- Sample BM8

Figure 26. FTIR results of BM8, 10% maltodextrin concentration

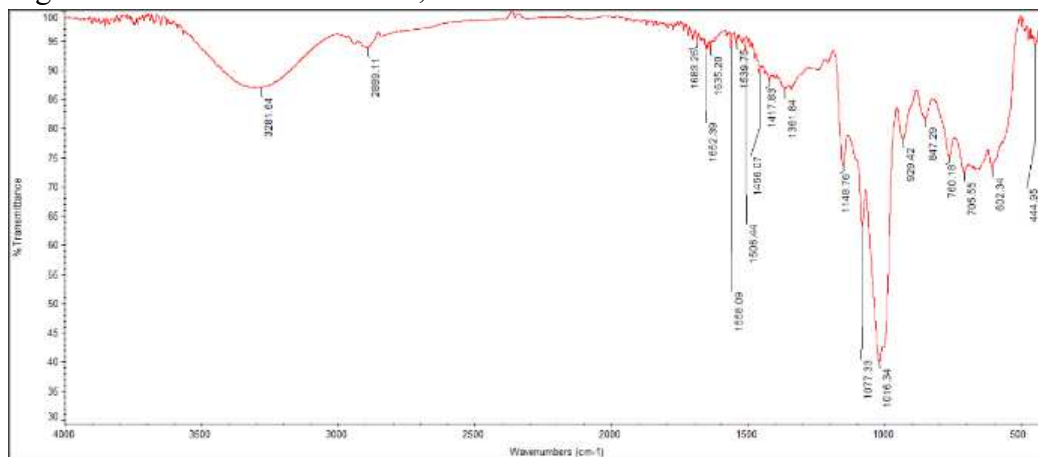


Figure 27. FTIR results of BM8, 20% maltodextrin concentration

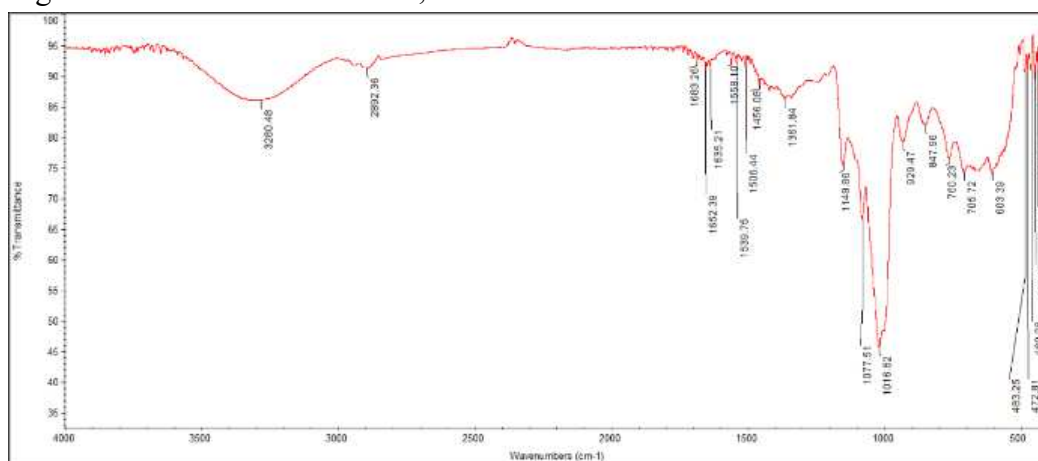
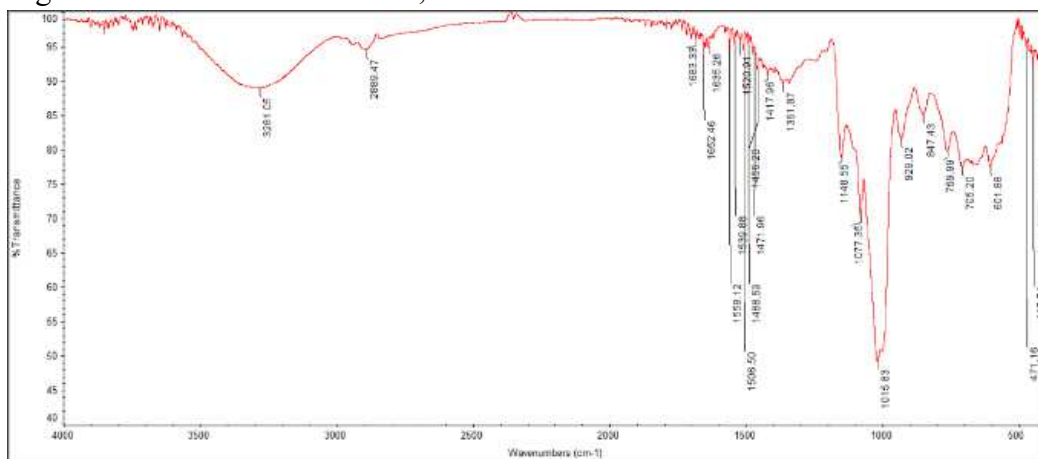


Figure 28. FTIR results of BM8, 30% maltodextrin concentration



Based on the results of infrared spectra, the hydrogen bond alcohol group was found in the BM 8 leaf type with variations in maltodextrin addition successively at 3281.64 cm⁻¹, 3280.48 cm⁻¹, and 3281.05 cm⁻¹ characterized by a widened absorption area of the (O-H) bond with strong intensity in the alcohol group. The C-H alkane group in the infrared spectra of Stevia powder of leaf type BM 8 is shown in the peaks of 2889.11 cm⁻¹, 2892.36 cm⁻¹, 2889.47 cm⁻¹ which is characterized by the stretching vibration of the C-H bond with strong intensity in the alkane group. The C=C alkene group is shown at peak 1652.39 cm⁻¹, 1652.39 cm⁻¹, and 1652.46 cm⁻¹ which is characterized by the stretching vibration of the C=C bond with strong intensity in the alkene group. According to Tambe's research (2010), standard Stevioside contains carboxylic acids at a wavelength of 1011.48, in the BM 8 sample there are at wavelengths of 1016.34 cm⁻¹, 1016.82 cm⁻¹, and 1015.83 cm⁻¹, respectively. (Nandiyanto, 2019).

Conclusions

From the research results it can be concluded:

1. Stevia accession on the physicochemical characteristics of Stevia powder extract affects the response of dissolving time, total yield, hygroscopicity, camba density, moisture content, total sugar content, Stevioside analysis, Rebaudioside-A analysis, and antioxidant content.
2. The concentration of maltodextrin on the physicochemical characteristics of Stevia powder extract affects the response of dissolving time, total yield, hygroscopicity, camba density, water content, total sugar content, Stevioside analysis, Rebaudioside-A analysis, and antioxidant content.
3. The interaction between Stevia accession and maltodextrin concentration on the physicochemical characteristics of Stevia powder extract affected the response of dissolving time, total yield, hygroscopicity, water content, total sugar content, Stevioside analysis, Rebaudioside-A analysis, and antioxidant content.
4. On further SEM analysis, the 3 selected Stevia accessions and the variation of maltodextrin concentration addition have the same particle shape, particle size, and constituent elements. The functional groups produced by 3 types of Stevia leaves and variations in the addition of maltodextrin in FTIR analysis have almost the same functional group peaks, so the functional groups contained in Stevia powder extracts with accessions and the addition of maltodextrin concentrations are the same.

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Ethics statement: not applicable

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