Journal of Bio & Geo Material and Energy (BiGME)
Volume 5 No. 1, March 2025
P-ISSN: 2808-1560 E-ISSN: 2808-1404

Morphological Analysis and Composition of Natural, Ivory, and Oily Types of Ms Glow Powder Using Scanning Electron Microscope (SEM) and X-Ray Fluorescence (XRF)

P. Vela[1], F. Deswardani[1*], M.F Afrianto[1], N.S.N. Selamat[2]

[1] Physics Study Program, Faculty of Science and Mathematics, Jambi University, Kampus Mendalo, Jl Raya Jambi-Ma.Bulian, Muaro Jambi, Jambi, Indonesia
[2] Bachelor (Hons.) Student in Science Chemistry and Management, Faculty of Applied Sciences, Universiti Teknologi MARA, Malaysia

E-mail : frastica.deswardani@unja.ac.id

Article info :

Submitted : June 2024
Revised : October 2024
Accepted : October 2024
Published : March 2025

Abstract :
This study was conducted to determine the morphology and composition of loose powder. This study used 3 types of MS Glow brand loose powder, namely natural, ivory, and oily. Morphological characterization was carried out using a Scanning Electron Microscope (SEM), while the composition was carried out using X-ray fluorescence (XRF). The morphology of MS Glow brand loose powder, ivory, natural and oily types is round with an average particle size of each sample A, B and C, namely 62 nm, 48 nm and 47 nm so that it can be classified into nanoparticles. The results of the XRF test showed that all samples contained the elements Mg, Al, Si, K, Ti, and Fe.These elements are found in different compositions of MS Glow brand loose powder. The XRF test also showed that all samples did not contain hazardous elements such as Lead (Pb), mercury (Hg) and Cadmium (Cd) and met BPOM standards. Keywords: Loose Powder; SEM; XRF

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1. Introduction

The use of cosmetics has been around for centuries. Cosmetics can be defined as substances that can protect or enhance appearance. (Adianti et al., 2023). Currently, various cosmetics can help achieve a smooth facial appearance, such as foundation, concealer, and powder. The foundation is usually liquid-based, formulated to match skin tone, and applied to the entire face to reduce uneven skin tone. Concealer is also liquid-based and skin-coloured but is generally only used to cover blemishes, not the entire face. Powder is also adjusted to skin tone, but its main purpose is not to cover redness or blemishes but to reduce shine that may arise due to oil on the skin. In addition, powder can provide waterproof properties, and absorb and retain fragrance on the skin (Kulikov et al., 2012). One of the most widely used cosmetic product groups is loose powder. Loose powder can help tighten the foundation and provide a specific look by reflecting light in good colours or spreading light evenly across the skin's surface. In addition to perfecting the appearance, powder can also provide sunscreen protection. The particle size distribution of these components affects the appearance, stability, and protection of sunscreens (Steiling et al., 2018)

The advancement of technology and cosmetic science that continues to develop positively impacts on the use of nanotechnology in cosmetics. One is nanoparticle material in cosmetics, which inhibits ageing so the skin looks younger. Nanoparticles have advantages, including more effective penetration into the skin, controlled and sustainable release of cosmetic compounds, high stability, specific targeting, and efficiency, so there is little chance of side effects (Santos et al., 2019). MS Glow products are one example of very well-known among Indonesian women. The MS Glow company assures to consumers that the products offered have been clinically tested using natural ingredients, are alcohol-free, and contain substances that do not exceed BPOM regulations.

Several previous studies have succeeded in analyzing the composition of elements in cosmetic products using various characterization techniques such as XRD (X-ray diffraction), XRF (X-ray flourescence) and AAS (Atomic Absorption Spectrophotometer). Research conducted by Boycott, G. (2014) successfully analyzed several brands and types of cosmetics using XRD and XRF for forensic purposes. In addition, there is also research conducted by Yugatama et al. (2019) on the analysis of lead content in cosmetics using the Atomic Absorption Spectrophotometry (AAS) test tool. From their research, it was obtained that in the samples used, the lead content in the cosmetics was still in the category that met the requirements of BPOM (Ministry of Health of the Republic of Indonesia). Furthermore, Kulikov et al. (2012) also classified several loose powders using XRF. Analysis of cosmetic products, especially regarding morphology, is still rarely found. SEM testing is needed to provide information on morphology and particle size. Particle size on a nanoscale has great benefits, especially in developing of nanocosmetics. The smaller the particle size in loose powder, the more evenly it will be distributed on the skin of the face to cover the pores of the face.

2. Research Method

This research was conducted at the Faculty of Science and Technology, University of Jambi. Data collection and sample testing were carried out at the Laboratory of the Faculty of Science and Technology, University of Jambi and Syiah Kuala University. SEM (Scanning Electron Microscopy), XRF (X-Ray Fluorescence), Analytical Balance and Spatula. The materials used in this study were loose powder with the MS Glow brand with the types Hay To Shine Natural, Hay To Shine Ivory and Oily To Matte. Samples in powder form were characterized using SEM to observe surface morphology and particle size. The results of SEM data in the form of 3-dimensional images were analyzed using ImageJ software to obtain particle size and holograms were made to see the paticle size distribution using Orogin software. The data (XRF) obtained was analyzed using SPECTRAplus, SPECTRA.ELEMENTS, and SPECTRA EDX software. The results of XRF processing are displayed in the form of a table containing the element content and its percentage.

3. Result and Discussion

The research material used is MS Glow brand loose powder. There are three types of MS Glow brand loose powder used, namely, Hay to Shine ivory, Hay To Shine Natural and Oily to Matte. Each sample is given a name, as seen in Table 1.

Table 1. The Naming of Samples of Loose Powder Types of MS Glow Brand

No	Sample Name	Sample code
1	*Hay to Shine ivory*	A
2	*Hay To Shine Natural*	B
3	*Oily to Matte*	C

The three samples were analyzed using SEM and XRF. The samples analyzed were in powder form. Sample A, B and C were analyzed using SEM to determine the microstructural characteristics of the MS Glow brand loose powder sample. In addition to using SEM, the samples were analyzed using XRF to identify the main elements of the loose powder. In addition, XRF also allows the measurement of the relative concentration of the elements contained in the loose powder. Information on the concentration of each element can be used to control the quality of the powder by checking the quality standards set by

BPOM. XRF can also be used to detect the presence of contaminants in loose powder.

Characterization with SEM (Scanning Electron Microscope)

SEM (Scanning Electron Microscope) analysis was used to determine the morphology and particle size of the MS Glow brand loose powder. The magnification used on the sample was 30,000 times. The SEM results of ivory loose powder with a magnification of 30,000 times are shown in Figure 1. Based on Figure 1 (a), the results of the SEM analysis at a magnification of 30,000 show that the particles appear to have a round shape. In addition, the SEM results also show lumps caused by particles that are still piled up. Particles that stick to each other cause agglomeration. Agglomeration is the joining of small particles into larger particles. Agglomeration in nano-sized particles often occurs because nanoparticles have a large specific surface area, so they tend to be unstable and form a state of agglomeration. (Kadarisman et al., 2020).

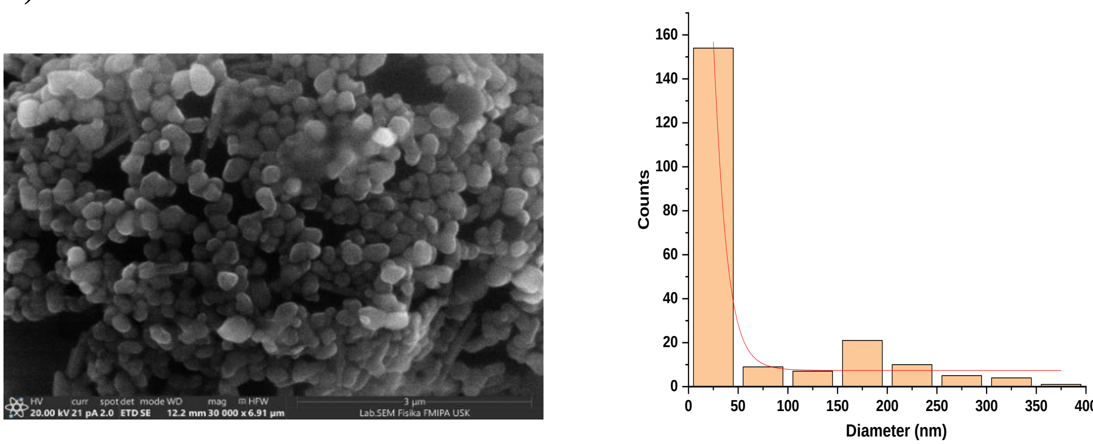

Figure 1. a) SEM results of Sample A and b) Histogram of particle distribution pattern.

The particle size distribution pattern of sample A in Figure 1 (b) shows that the particle size distribution is in the range of 5-350 nm. The particle size in the range of 5-50 nm shows the highest frequency. This shows that the majority of particle sizes are in that range. The average particle size in sample A is 62 nm.

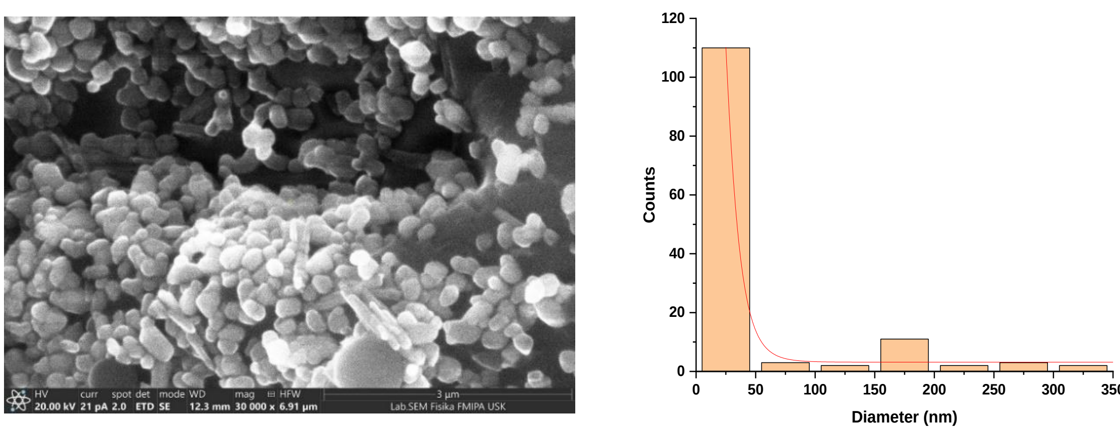

Figure 2. a) SEM Results of Sample B and b) Histogram of Particle Distribution Pattern

The results of the SEM analysis on sample B show a shape that is almost the same as that of sample A, which is round, as seen in Figure 2 (a). The microstructure of sample B also shows that there is still agglomeration with the presence of small, non-homogeneous particles. The non-uniform particle size and particle size distribution of sample B can be seen in Figure 2 (b). The particle size distribution pattern of sample B shows that the particle size distribution is in the range of 5-350 nm. The highest frequency is found in particle sizes of 5-50 nm. This shows that the majority of particle sizes are in that range. The average particle size in sample B is 48 nm.

Based on Figure 7 (a), the results of SEM analysis at a magnification of 30,000 show that the particles appear to have the same shape as samples A and B, which are round. However, the agglomeration in sample C looks less than in samples A and B. In addition, sample C also has particles

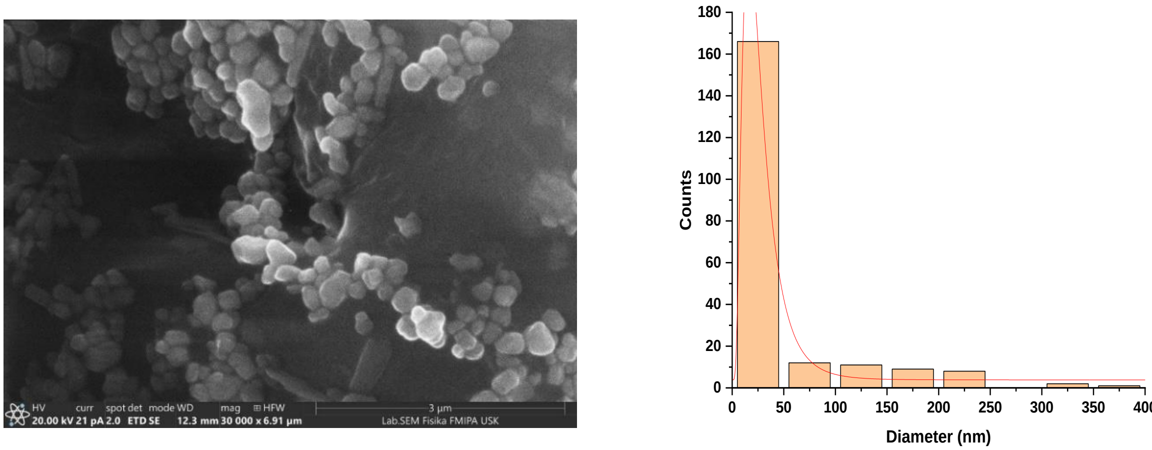

Figure 3. a) SEM results of Sample C and b) Histogram of particle distribution patterns.

If seen from the particle size distribution pattern in Figure 7 (b), the particle size distribution of sample C is in the range of 5-350 nm. The highest frequency is in 5-50 nm particle size range. This shows that the majority of particle sizes are in that range. The average particle size in sample C is 47 nm. The average particle size of the three samples, A, B and C, each 62 nm, 48 nm and 47 nm, it shows that all samples can be classified as nanoparticles because they are <100 nm in size. Nanoparticles in loose powder can cover and provide smoother and more even results when applied to the face. This is because nanoparticles can fill the skin's pores more effectively, making them suitable for all skin types. In addition, nanoparticles have a proportionally larger surface area, thus they are more effective in absorbing oil and sweat from the skin.

Characterization with XRF (X-ray fluorescence)

The results of the analysis of element content using X-ray fluorescence on ivory loose powder of the MS Glow brand can be seen in Table 2. In general, sample A contains several elements, namely Mg, Al, Si, K, Ti, and Fe. These elements are often found in loose powder as compounds such as Talc, silica, mica, kaolin, magnesium stearate, and titanium dioxide (Steiling et al., 2018). Based on the table, it can be seen that sample A does not contain elements that are harmful to cosmetics, such as Lead (Pb), mercury (Hg) and Cadmium (Cd). This can be seen from the XRF results, which show the percentage of content of these elements, which is 0.00%.

Based on the composition test result using XRF, the element with the highest percentage is Si (46.05%). Silicon can be found in compounds such as silica (SiO_2), which absorb excess oil on the skin and give a matte appearance to the powder. The second element content is Ti (16.20%). Titanium is usually found as of titanium dioxide (TiO_2) which provides light and opacity to loose powder and protect it from UV sunlight. The third element content is Mg (12.62%). Magnesium can be found in loose powder, especially if the powder contains natural ingredients such as Talc. Talc helps in providing soft and smooth results on the skin. The fourth element content is Al (10.05%). The Al element in loose powder is usually in the form of Aluminum chlorohydrate or Aluminum hydroxide compounds, which are useful for absorbing oil trapped around the pores and, thus, disguising the appearance of large pores. The fifth element content is K (9.12%) The last is the Fe element content (5.17%), which gives colour to loose powder, especially to match skin colour.

Table 2. Elemental Content in Samples

No	Element	A (%)	B (%)	C (%)
1	Mg	12.62	12.71	12.71
2	Al	10.05	10.01	10.01
3	Si	46.05	45.55	45.55
4	K	9.12	8.95	8.95
5	Ti	16.20	15.69	15.69
6	Fe	5.17	6.46	6.46
7	Hg	0.00	0.00	0.00
8	Pb	0.00	0.00	0.00
9	Cd	0.00	0.00	0.00

The results of the analysis of element content using X-ray fluorescence on the natural loose powder of the MS Glow brand can be seen in Table 2. Sample B has the same content as sample A. However, there is a slight difference in the percentage of each composition. Sample B contains the elements Si, Ti, Mg, Al, K, and Fe, respectively (45.55%), (15.69%), (12.71%), (10.01%), (8.95%), (6.46%). The same element content is also found in sample C, as seen in Table 2. Sample C also contains the elements Si, Ti, Mg, Al, K, and Fe, respectively (46.96%), (15.19%), (12.81%), (10.49%), (8.89%), (4.83%).

Based on the data obtained in the table, it can be seen that the elements contained have a percentage that still meets the BPOM standard regulations. This can be seen from compounds with a maximum limit of use as cosmetic ingredients, such as TiO2 of 25%. The XRF results showed a lower percentage of each sample (16.20%), (15.69%) and (1519%). All samples showed the same element content. These elements are in accordance with the composition of the ingredients listed on the MS Glow brand loose powder product packaging label,as seen in Figure 4.

a b c

Figure 4. Composition on Packaging a) Sample A b) Sample B c) Sample C

The composition of the ingredients contained in each type of loose powder shows the content of elements that match the XRF results. Table 3 shows the composition of all ingredients along with their respective chemical formulas. Based on the table, it can be seen that the compounds in all compositions of MS Glow brand loose powder contain elements that match the XRF results, namely Mg, Al, Si, K, Ti, and Fe. Elements that are not detected such as, C (Z = 6), O (Z = 8), H (Z = 1) and B (Z = 5) because the elements have low atomic numbers, hence they have few electrons in their atomic structure. As a result, the fluorescence produced by these elements is usually very weak and difficult to detect with XRF instruments which are generally optimized for elements with higher atomic numbers. This is in accordance with the XRF results which detect starting from the element with atomic number 11, namely

Na. Based on the percentage of element content obtained in Tables 2, 3 and 4, it can be seen that the element with the highest percentage is Si. This can be associated with the sample's composition, which contains many Si elements such as talc, mica, silica, Triethoxycaprylysilane and Methicone. In sample C, Methyl methacrylate crosspolymer is an additional element found in oily to matte loose powder. This material is often used in loose powder formulations and other cosmetic products. It is a synthetic polymer that provides various benefits for cosmetic products. It does not clog pores, so it is safe for skin that is prone to acne. In addition, it can absorb oil, help control shine and provide a more durable matte appearance, hence it is suitable for oily and acne-prone skin types.

Table 3. Composition of MS Glow Brand Loose Powder Packaging

Composition on packaging	**Chemical Formula**
Talc	$Mg_3Si_4O_{10}(OH)_2$
Polymethyl Methacrylate	$(C_5O_2H_8)$
Mica	$KAl_2(AlSi_3O_{10})\ (OH)_2$
Silica	SiO_2
Boron Nitrate	BN_3O_9
Isononyl Isoninanoate	$C_{18}H_{36}O_2$
Triethoxycaprylysilane	$C_{14}H_{32}O_3Si$
Aluminium Hydroxide	$Al\ (OH)_3$
Phenoxyethanol	$C_8H_{10}O_2$
Methicone	$C_4H_{12}OSi$
Titanium Dioxide	TiO_2
Iron Oxide Yellow	FeO_3
Iron Oxide Black	FeO_3
Iron Oxide Red	FeO_3
Fragrance	
Methyl methacrylate crosspolymer	$C_{15}H_{22}O_6$

Source: ((Mohiuddin et al, 2019);(Shinde et al, 2021)

4. Conclusion

SEM characteristics of MS Glow brand loose powder types Hay to Shine ivory, Hay To Shine Natural, and Oily to Matte are round with an average particle size of each sample A, B and C, namely 62 nm, 48 nm and 47 nm so that they can be classified into nanoparticles. Nanoparticles in loose powder can cover and provide smoother and more even results when applied to the face. This is because nanoparticles can fill skin pores more effectively,thus they are suitable for all skin types. XRF test results show that all samples contain Mg, Al, Si, K, Ti, and Fe elements. All these elements are found in the composition of MS Glow brand loose powder. XRF tests also show that all samples do not contain hazardous elements such as Lead (Pb), mercury (Hg) and Cadmium (Cd) and meet BPOM standards.

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