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Development of Blush On Powder Formulation using Beetroot Extract (*Beta vulgaris* L.) as Natural Colorant

Pengembangan Formulasi Blush On Powder menggunakan Ekstrak Umbi Bit (*Beta vulgaris* L.) sebagai Pewarna Alami

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ABSTRACT

Research on the development of natural dyes using beetroot (*Beta vulgaris* L.) has been investigated. Beetroot extract was obtained using the maceration method and then characterized through phytochemical screening tests, TLC (Thin Layer Chromatography), FT-IR (Fourier Transform Infrared), and XRD (X-ray Diffraction). The extract was developed as an active ingredient in a blush on powder formulation. The formulation was evaluated through organoleptic testing, homogeneity, pH, and spreadability tests, as well as stability testing using the freeze and thaw method. The results showed that the beetroot extract yield was 4.64%, containing secondary metabolites in the form of alkaloids, flavonoids, saponins, tannins, and terpenoids, with an Rf value of 0.54, the presence of chemical structures in the form of O-H, C-H, C-H, and R-CH=CH-R, and an amorphous form. Formulation was carried out by varying the beetroot extract to F1 (2%), F2 (5%), and F3 (8%) and control F0. Based on organoleptic testing, the formulations showed light brown color for F1, brown for F2, and dark brown for F3, homogeneous, pH in the range of 6.56-6.94, and spreading power in the range of 5-7 cm. The stability test showed a normality test >0.05, indicating that the formulation was normally distributed. The homogeneity test >0.05 showed no significant differences between the formulations. The one-way ANOVA test $p<0.05$ showed that the formulation had an effect on the pH value, while the post hoc Tukey HSD test $p<0.05$ showed no significant differences between the formulations.

Keywords: Beetroot, TLC, FT-IR, XRD, Blush On, Natural Colorant

ABSTRAK

Penelitian tentang pengembangan pewarna alami menggunakan umbi bit (*Beta vulgaris* L.) telah dilakukan. Ekstrak umbi bit diperoleh menggunakan metode maserasi kemudian dikarakterisasi melalui uji skrining fitokimia, KLT (Kromatografi Lapis Tipis), FT-IR (*Fourier Transform Infrared*), dan XRD (*X-ray Diffraction*). Ekstrak dikembangkan sebagai zat aktif dalam formulasi blush on. Formulasi dilakukan evaluasi berupa uji organoleptik, homogenitas, pH, dan daya sebar serta uji stabilitas menggunakan metode freeze and thaw. Hasil penelitian menunjukkan perolehan rendemen ekstrak umbi bit sebesar 4,64%, mengandung metabolit sekunder berupa alkaloid, flavonoid, saponin, tanin, dan terpenoid, nilai Rf 0,54, keberadaan struktur kimia berupa O-H, C-H, C-H, dan R-CH=CH-R, dan memiliki bentuk amorf. Formulasi dilakukan dengan memvariasikan ekstrak umbi bit sebesar F1 (2%), F2 (5%), dan F3 (8%) serta kontrol F0. Berdasarkan uji organoleptik formulasi menunjukkan warna F1 cokelat muda, F2 cokelat, dan F3 cokelat tua, homegen, pH berada pada rentang 6,56-6,94, daya sebar pada rentang 5-7 cm. Uji stabilitas menunjukkan uji normalitas >0,05 sehingga formulasi terdistribusi normal, uji homogenitas >0,05 menunjukkan tidak terdapat perbedaan yang signifikan antar formula, uji one way anova $p<0,05$ menunjukkan adanya pengaruh formulasi terhadap nilai pH, uji post hoc tukey HSD $p<0,05$ menunjukkan tidak adanya perbedaan signifikan antar formula.

Kata kunci: Umbi Bit, KLT, FT-IR, XRD, Blush On, Pewarna Alami

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INTRODUCTION

The cosmetics industry in Indonesia has experienced annual growth according to data from the Food and Drug Supervisory Agency (BPOM) and the Indonesian Cosmetics Association, in 2021, Indonesian cosmetics industry grew to 819 companies and reached 1,039 by the end of 2023. By 2024, the number of cosmetic companies in Indonesia projected to exceed 1,500. Based on these figures, Indonesia holds significant potential for the development of its cosmetic industry. This potential is further supported by the abundance of natural resources in Indonesia (Mileneo, 2024). Cosmetics are substances used on the outer parts of the human body (epidermis, hair, nails, lips, external genital organs) or teeth and oral mucosa (Adjeng *et al*., 2023). In its development, cosmetics are used to enhance appearance, thereby boosting self-confidence (Ayuni *et al*., 2019). Skin generally consists of sweat glands, blood vessels, and melanocytes (Utami *et al.*, 2023). The skin on the face has more blood vessels compared to other parts of the skin (Wibowo, 2009).

Blush is a type of ornamental cosmetic used to add color to the cheeks, resulting in an artistic touch to makeup (Ramadani *et al*., 2023). Blush on is categorized based on its formula, namely cream and powder. Cream blush on is typically used on normal to dry skin, resulting in a dewy makeup look, while blush on powder not only provides an ornamental effect but also helps control excess oil on the skin (Purnomo *et al*., 2021).

Beetroot is a highly nutritious food source. It contains several secondary metabolites, including tannins, saponins, alkaloids, flavonoids, glycosides, steroids, and terpenoids. It also contains minerals such as Fe, Mg, Cu, Na, K, Mn, Ca, and Zn (Maimunah *et al*., 2021). Beetroot also contains the primary pigment-forming component betacyanin. Betacyanin is a derivative of betalain, which is water-soluble (Pratiwi *et al*., 2019).

The formulation development will be carried out specifically using beetroot extract as a substitute. This research is experimental and was conducted at the Research & Analysis Laboratory, Natural Materials Technology Laboratory, Sterile Technology Laboratory, and Pharmaceutical Technology Laboratory, Pharmacy Program, Medistra Indonesia School of Health Sciences.

RESEARCH METHODOLOGY

Tool

Analytical digital scale (Biobase, China); rotary evaporator (Buchi, Switzerland); water bath (B-One, China); oven (Memmert, Germany); UV viewing cabinet (Camag, Germany); silica gel 60 GF254 KLT plate (Merck, Germany); vacuum desiccator (Normax, Indonesia); digital pH meter (Ezdo, Taiwan); porcelain dish (Local); thermometer (Local); standard laboratory glassware (Pyrex, China); mortar and pestle (Local); and blush on powder packaging.

Materials

Beetroot extraction was carried out using the maceration method with fresh beetroots. Maceration was performed using 96% ethanol solvent at a ratio of 1:10. Maceration was carried out for 5 days, followed by remaceration for 2 days. The filtrate is concentrated using a rotary evaporator at a speed of 50 rpm at a temperature of 40°C until a thick extract is obtained. The thick extract is evaporated again in a porcelain dish over a water bath until a thick mass is formed (Putri *et al*., 2021).

Standardization of Extracts

Phytochemical Screening

Flavonoid

Put 1 g of extract in a test tube, then add 1 mg of Mg powder and 5 drops of concentrated HCl. A positive result is indicated by the formation of a red or orange color (Werdiningsih, 2023).

Saponin

Put 1 g of extract into a test tube, add 10 mL of hot water, cool it down, then shake it vertically for 10 seconds. If you see white foam 1-10 cm high, then the solvent is positive for saponin (Werdiningsih, 2023).

Alkaloid

Put 500 mg of extract to a test tube, add 1 mL of 2 N hydrochloric acid and 9 mL of water, then heat for 2 minutes, cool, and filter. The filtrate is then divided into 2 parts (La *et al*., 2020). In test tube 1, add 2 drops of Dragendorff's reagent; if an orange precipitate forms, the result is positive for alkaloids. In the second test tube, add 2 drops of Mayer's reagent; if a white or yellow precipitate forms, the result is positive for alkaloids (Werdiningsih, 2023).

Terpenoids and Steroids

Put 0.5 g of extract into a test tube, add 1 mL of chloroform, 1 mL of anhydrous acetic acid, and 1 mL of H_2SO_4, then shake. If a yellow or red color appears, the result is positive for terpenoids. However, if a green color appears, the result is positive for steroids (Werdiningsih, 2023).

Tannin

Put 1 g of extract into a test tube, add 10 mL of hot water, and boil for 5 minutes. Add 3-4 drops of $FeCl_3$. If a greenish-black or blue color forms, then it is positive for tannin (Werdiningsih, 2023).

Thin Layer Chromatography

Prepare the mobile phase of n-butanol:acetic acid:distilled water (4:1:5) and saturate it. Weigh 1 g of extract and dissolve it in 96% ethanol. Spot the sample on the TLC plate and place it in the chamber containing the mobile phase until elution. The TLC plate is analyzed under a 254 nm and 366 nm UV lamp, then the Rf value of each spot that appears is calculated (Werdiningsih, 2023).

FT-IR (Fourier Transform Infrared)

The functional group of beetroot extract will be analyzed using an FTIR (Fourier Transform Infrared) spectrophotometer at a wavelength of 600-4000 cm^{-1}. Record the data obtained (Asra *et al*., 2020).

XRD (X-ray Diffraction)

The sample is prepared on a preparation table, where ± 2 spoonfuls of the sample are placed in a holder and then compacted using a press holder machine in order to obtain the desired peak. After the sample preparation is

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complete, it is placed in the XRD device and the results will be visible on the monitor (Rahayu *et al*., 2023).

Blush on Manufacturing Procedure

Grind zinc oxide, then sieve using a 100 mesh sieve. In a mortar, add zinc oxide, kaolin, mica, and BHT, then grind until homogeneous. Then add beetroot extract (*Beta vulgaris* L.) and grind until homogeneous. After homogenization, add part of the talc and grind until homogeneous (mass 1). In a hot mortar, add isopropyl myristate and dimethicone, then grind until homogeneous. After homogenization, add the remaining talc and grind until homogeneous. Add oleum rosae, then grind again until homogeneous. After a homogeneous mass is formed, sieve using a number 100 sieve (mass 2). Combine mass 1 and mass 2, then grind again until homogeneous and put the blush on powder preparation into a blush on powder container (Ramani *et al*., 2021) (Table 1).

Table 1. Blush On Powder Formulation in Concentration % b/v

Ingridients	Concentration (%)			
	F0	**F1**	**F2**	**F3**
Beetroot Extract	-	2	5	8
Zinc oxide	0.7	0.7	0.7	0.7
Kaolin	1.0	1.0	1.0	1.0
Isopropyl Miristat	0.75	0.75	0.75	0.75
Mica	20.0	20.0	20.0	20.0
Dimetikon	10.0	10.0	10.0	10.0
BHT	0.18	0.18	0.18	0.18
Talk	Ad 100	Ad 100	Ad 100	Ad 100
Oleum Rosae	qs	qs	qs	qs

Description:
F0: Blush on powder without the addition of beetroot extract (blank)
F1: Blush on powder with 2% beetroot extract concentration
F2: Blush on powder with 5% beetroot extract concentration
F3: Blush on powder with 8% beetroot extract concentration

EVALUATION

Organoleptic Test

Organoleptic testing was conducted by observing the preparation in terms of odor, color, and shape. Testing was carried out on days 0, 7, 14, 21, and 30 (Rahayu *et al*., 2020).

Homogeneity Test

The test was conducted by placing 1 g of the preparation on a glass slide, covering it with another glass slide, and then observing its homogeneity. The homogeneity test was conducted on days 0, 7, 14, 21, and 30 (Rahayu *et al*., 2020).

pH Test

A sample weighing 1 g was placed in a plastic pot and dissolved in 100 mL of distilled water, then analyzed using a pH meter. The pH requirement for a good blush on sample is 4-7 (Aulia *et al*., 2022). Testing was conducted on days 0, 7, 14, 21, and 30 (Rahayu *et al*., 2020).

Spreadability Test

On a flat surface, place 0.5 g of the preparation, then add weights of 50 g, 100 g, and 250 g and leave for 1 minute. Observe the diameter of the spread area (Dominica & Handayani, 2019). Testing was carried out on days 0, 7, 14, 21, and 30 (Rahayu *et al*., 2020).

Stability Testing Using the Freeze and Thaw Method

Stability testing was conducted using the Freeze and Thaw method by weighing 2 g of each blush powder preparation and placing it in 8 tightly sealed vials. Four vials were used as controls and stored at 25°C, while the remaining four vials were used for the Freeze and Thaw cycle, where the vials were stored at 4°C for 24 hours, then removed and placed at 40°C for 24 hours. This process was counted as cycle 1 to observe changes in organoleptic properties, pH, and homogeneity. This was observed for 6 cycles, and changes in organoleptic properties, pH, and homogeneity were observed at each cycle (Rasyadi *et al*., 2021).

Data Analysis

The data obtained from the variation in red beet root extract (*Beta vulgaris* L.) blush on preparations was statistically analyzed using SPSS version 27 with the One Way Anova method. The One Way Anova test was used to determine the average of the blush on powder formulation.

RESULTS AND DISCUSSION

The research conducted was experimental in nature to determine the effect of beetroot extract as a natural coloring agent. The research was conducted using fresh beetroot, as fresh beetroot has a water content of around 87%. The extraction process used the maceration method with 96% ethanol as the solvent. The extract was then characterized by phytochemical screening, TLC, FT-IR, and XRD. Characterization was carried out to identify the physicochemical properties of the extract before formulation development.

The yield of beetroot extract was 4.64%. The extract yield is considered good if the value obtained is more than 10%. This indicates that the extract yield is not yet optimal, due to the use of fresh beetroot, which has a water content of 87.69% per 100 g. Based on organoleptic tests, the beetroot extract has a reddish-brown color. The research continued with phytochemical screening analysis, which was conducted to identify the groups of secondary metabolites contained in beetroot extract. The results of the phytochemical screening analysis can be seen in the Table 2.

Table 2. Phytochemical Test Result

Phytochemical Test	Result
Flavonoid	+
Saponin	+
Alkaloid	+
Terpenoid	+
Steroid	-
Tanin	+

Characterization was performed by conducting TLC analysis, a method used to identify compound separation using a mobile phase based on the degree of polarity. The analysis results showed an Rf value of 0.54. The Rf value of betacyanin compounds in beetroot extract was in the range of 0.41-0.80 (Vifta, 2025), so the analysis results were consistent with the literature. FT-IR analysis was performed to analyze compounds by measuring infrared light absorption in samples. This method was used to identify functional groups and chemical structures through infrared spectra generated from the interaction between infrared light and sample molecules. The FT-IR analysis results in Figure 1 show the presence of chemical structures in the form of O-H, C-H, C-H, and R-CH=CH-R (Figure 1).

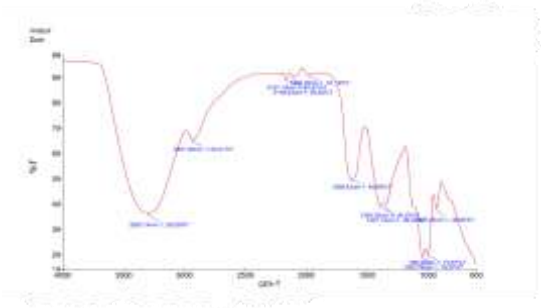

Figure 1. FT-IR Spectrum of Beetroot

The analysis continued with an XRD test, which was conducted to identify the crystal phase of the material using X-ray diffraction, thereby producing a diffraction pattern as a fingerprint of the atomic arrangement in a sample. The analysis results in the diffractogram (Figure 2) showed that the beet root extract had an amorphous form.

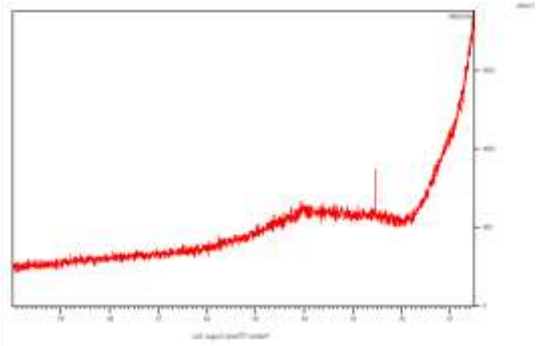

Figure 2. Extract diffractogram of beetroot extract

Based on the analysis of phytochemical screening identification, TLC, FT-IR, and XRD, beetroot extract has characteristics of betacyanin compounds and an amorphous form, which can be developed into a powder blush formulation because the amorphous form can increase solubility and bioavailability but has the disadvantage of physical instability.

The development of blush on powder formulations was carried out by varying the concentration of beetroot extract. Beetroot extract was varied at concentrations of 2%, 5%, and 8%. This variation was done to see the effect of sample concentration on the blush powder formulation. A control formulation consisting only of blush on powder base was also developed for this study to serve as a standard for comparison in the experiment.

The formulation results were then evaluated and tested for stability. The evaluation was conducted to measure the extent to which the research objectives were achieved by identifying and comparing the strengths and weaknesses of each preparation, in the form of organoleptic tests, pH homogeneity, and spreadability. Testing was conducted on days 0, 7, 14, 21, and 30. This was done to determine whether physical changes in the preparation could be observed periodically so that the time of change could be identified and used as basic data for further analysis and development. The organoleptic evaluation results show that blush on powder F0 has a white color, F1 has a solid white color, F2 has a light brown color, and F3 has a dark brown color. The color changes in the formulas vary, with higher extracts producing more intense colors, as blush must be bright enough and suitable for cosmetic purposes. Formulas F0, F1, F2, and F3 have a rose scent, a fine powder texture, and a smooth texture when applied to the skin. The homogeneity of the blush on powder formulation was tested by spreading the formulation evenly on a glass slide. The analysis results showed that F0, F1, F2, and F3 had a homogeneous form. A homogeneous formulation indicates that all ingredients are evenly distributed. Homogeneity is influenced by the stirring speed during the powder blush formulation process, which aims to reduce particle size so that the particles are evenly distributed throughout blush on powder. The study was conducted by testing the pH level, which ranges from 4 to 7 for facial skin. The test results showed that F0, F1, F2, and F3 had different pH levels (Figure 3). The difference in pH levels in the test was due to the increasing concentration of extract in each blush on powder formula, but they were still within the pH range of facial skin, thus posing a low risk of skin irritation.



Figure 3. Graph of pH Value

In the spreadability test, the optimal range was between 5-7 cm (Dominica & Handayani, 2019). Based on the spreadability test in Table 3, F0, F1, F2, and F3

were in the 5.0-6.5 cm diameter range. The decrease in spreadability occurs due to the addition of extract concentration in each formula, indicating that the higher the extract concentration, the lower the spreadability of the formulation due to the addition of the extract, and the resulting spreadability will be more extensive with increasing load. Spreadability is a parameter for even distribution, making it easier to use blush on powder (Table 3).

Table 3. Spreadibility Test Result

Days	Formula	Spreadibility (cm)		
		50 g	100 g	250 g
0	F0	6.5	6.9	7.0
	F1	5.7	5.8	6.2
	F2	5.4	5.5	5.6
	F3	5.1	5.2	5.5
7	F0	6.6	6.8	6.9
	F1	5.3	5.4	6.1
	F2	5.1	5.2	5.5
	F3	5.0	5.1	5.5
14	F0	6.4	6.6	6.5
	F1	5.4	5.8	6.0
	F2	5.0	5.1	5.3
	F3	5.0	5.0	5.3
21	F0	5.6	6.3	6.5
	F1	5.2	5.5	6.0
	F2	5.0	5.3	5.5
	F3	5.0	5.0	5.7
30	F0	5.8	6.1	6.4
	F1	5.5	5.7	5.9
	F2	5.0	5.2	5.5
	F3	5.0	5.0	5.4

Stability testing was conducted to ensure that each formulation met quality standards in packaging and storage for a certain period of time. Stability testing was conducted using the freeze and thaw method, which was carried out using extreme temperature cycles. Stability testing was conducted for 6 cycles, followed by organoleptic, homogeneity, and pH testing. The stability test results were analyzed using statistics. Based on the analysis data, the normality test showed significant values at F0=0.964, F1=0.265, F2=0.588, and F3=0.227, indicating that each formula had a significant value >0.05, so all formulas showed a normal distribution. The analysis was continued with a homogeneity test using the Levene statistical method. The analysis results showed F0=0.863, while F1, F2, and F3=0.396, indicating that each formula had a significant value >0.05, so all formulas showed homogeneous data. Based on the One Way Anova test, a significant value of 0.002 was obtained, so it can be concluded that the freeze and thaw stability test on F1, F2, and F3 during cycles 1 to 6 had a significant effect. from the data, the sig value is <0.05, so it can be concluded that there is an effect between the pH of all formulas during the freeze and thaw stability test in cycles 1 to 6.

CONCLUSION

Based on research, beetroot extract has reddish-brown pigments, contains secondary metabolites in the form of alkaloids, flavonoids, saponins, tannins, and terpenoids, an Rf value of 0.54, the presence of chemical structures in the form of O-H, C-H, C-H, and R-CH=CH-R, and has an amorphous form. Based on the characterization results, it was concluded that beetroot extract with an amorphous form has good solubility and bioavailability, which can be developed in blush on powder formulations by varying the beetroot extract content to F1 (2%), F2 (5%), and F3 (8%) and control F0. Based on organoleptic testing, the formulations showed light brown color for F1, brown for F2, and dark brown for F3, homogeneous, pH in the range of 6.56-6.94, and spreadability in the range of 5.0-7.0 cm. The stability test showed a normality test >0.05, indicating that the formulation was normally distributed. The homogeneity test >0.05 showed no significant differences between the formulations. The one-way ANOVA test p<0.05 showed that the formulation had an effect on the pH value, while the post hoc Tukey HSD test p<0.05 showed no significant differences between the formulations.

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