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Formulation And Evaluation Of Instant Drink Powder Preparation With A Combination Of Vitamin C And Zinc Sulfate Monohydrate

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Abstract
Vitamin C and Zinc Sulfate Monohydrate is a combination of active substances that play a role in improving the immune system and maintaining body health. This research aims to create a powder formulation of a combination of vitamin C and zinc sulfate that is safe for consumption. Vitamin C is a very sensitive substance and can be degraded into dehydroascorbic acid due to photooxidation and hydrolysis reactions. Vitamin C is easily degraded in aqueous media, at high pH, high temperatures, in the presence of oxygen and metal ions. Formulation in solid form such as powder is often chosen to increase the chemical stability and shelf life of vitamin C. Formulation of vitamin C and zinc in powder form also provides convenience for consumers who have difficulty swallowing in pill, tablet, or capsule form. The evaluation results showed that the preparation had good characteristics in most parameters, including white color, smooth texture, odorless, slightly sweet and sour taste, particle size of 0.7795 mm, flow time of 10 seconds, water content of 2.73%, angle of repose of 31.52°, dissolution time of 1 minute 29 seconds, bulk density of 0.64, tap density of 0.72, Hausner ratio of 1.12, and compressibility index of 11.11%. However, the preparation did not meet the requirements for particle size distribution due to the excessive number of fines and a pH value of 3.57 which was below the specified range (4–7). Therefore, the resulting formulation still requires further optimization to improve compliance with the preparation quality standards.

Keywords: Powdered Drink, Vitamin C, Zinc sulfate monohydrate, formulation.

INTRODUCTION

Instant powdered drinks are a type of beverage product characterized by practicality, easy solubility in water, and a relatively long shelf life (Yolandari, 2021). These products are generally produced through a crystallization process with the aid of a crystallizing agent, such as sucrose. The crystallization process involves heating the solution until it reaches saturation, increasing the solute concentration. During heating, sucrose molecules form crystal nuclei, which then grow into larger crystals, resulting in a dry powder that is easily dispersed in water (Rawar, 2024).

Vitamin C, or ascorbic acid, is an essential nutrient that plays a vital role in maintaining the body's physiological functions. This vitamin functions as an antioxidant, scavenging free radicals through an electron donor mechanism. Furthermore, vitamin C plays a role in collagen synthesis by acting as a cofactor for the enzymes lysyl hydroxylase and prolyl hydroxylase, which contribute to the formation of a stable collagen structure. Vitamin C is also known to help inhibit melanin formation by inhibiting the enzyme tyrosinase, thus contributing to the prevention of hyperpigmentation (Nurulhadi et al., 2024).

Despite its many benefits, vitamin C has a major weakness: its low stability. This vitamin is highly sensitive to environmental factors such as light, high temperature, alkaline pH, oxygen, and the presence of metal ions. Vitamin C degradation can occur through photooxidation and hydrolysis reactions that produce dehydroascorbic acid. This process is often characterized by a yellowish color change in the product. Furthermore, ascorbic acid degradation also involves a complex reaction with the enzyme ascorbate oxidase. In solution, vitamin C tends to be unstable and easily oxidized, although the conversion to dehydroascorbic acid is reversible (Tonthawi et al., 2023).

Zinc is an essential micronutrient that plays a role in various biological processes, including cell division, growth, wound healing, and the metabolism of macronutrients such as carbohydrates, lipids, and proteins. Zinc also plays a role in immune system regulation and insulin activity.

Furthermore, zinc has anti-inflammatory, antioxidant, antiviral, and immunomodulatory properties. Zinc deficiency can lead to an increased inflammatory response and decreased antibody production, thus impacting the immune system (Widowati et al., 2024).

The combination of vitamin C and zinc in an instant powdered drink is a potential approach to increasing effectiveness as an antioxidant and immunomodulator. In addition to providing health benefits, this dosage form also offers ease of preparation and consumption, potentially increasing compliance.

RESEARCH METHODS

Tools and materials

Analytical balance, stirring rod, mesh sieve (number 18, 20, 30, and 40), spatula, beaker, mortar, stamper, pH meter, pH indicator, glass funnel, flow rate tester, granulate flow tester, moisture analyzer, stopwatch, bulk density.

Ascorbic acid (vitamin C), zinc sulfate monohydrate, citric acid, aerosil, sucrose, saccharin, maltodextrin, distilled water.

Vitamin C and Zinc Powder Formula

Table 1. Vitamin C and Zinc Powder Formula

Material	Concentration	Function
Ascorbic acid (vitamin C)	10%	Active Ingredients
Zinc sulfate monohydrate	1.1%	Active Ingredients
Citric acid	2%	Adding sour taste
Maltodextrin	19%	Filler
Aerosil (colloidal silicon dioxide)	0.7%	*Glidant*
Sucrose	67%	Sweetener
Saccharin	0.2%	Sweetener

Research Procedures

Making Instant Vitamin C and Zinc Sulfate Monohydrate Drink Powder

The preparation of instant vitamin C and zinc powdered drinks begins with the preparation and weighing of the ingredients, namely ascorbic acid, zinc sulfate monohydrate, citric acid, sucrose, saccharin, maltodextrin, and aerosil. Sucrose and citric acid are ground separately until smooth. Ascorbic acid is then mixed with some aerosil and ground until homogeneous. Zinc sulfate monohydrate is ground and sieved using a 60–80 mesh. Next, the acid components (ascorbic acid + citric acid + aerosil) are mixed until homogeneous. Then maltodextrin, zinc sulfate, sucrose, and saccharin are added and homogenized. The mixture is sieved using a 40 mesh and packaged in airtight sachets.

In Process Control(IPC)

Organoleptic Test

Organoleptic evaluation is conducted by observing the shape, color, odor, and taste of the powder preparation using the five senses, then recording the results. A preparation is considered to meet the requirements if it is white, has a flat, round powder shape, and has a distinctive odor or is odorless (Ministry of Health of the Republic of Indonesia, 2020).

Particle Size Test

Particle size testing was carried out by weighing 10 grams of powder and then sifting it in stages using sieves with mesh numbers 18, 20, and 30. The powder retained on each sieve was collected and weighed. Particle size was determined based on the fraction retained on each mesh, then the results were recorded and analyzed. The requirement for powder particle size is not to exceed 1 mm (Anisa et al., 2025). Particle size was calculated using the formula:

$$\frac{\Sigma(bobot\ pada\ ayakan) \times (lubang\ ayakan)}{\Sigma bobot\ serbuk}$$

Particle Size Distribution Test

The test was carried out by weighing 100 grams of powder, then sifted in stages using sieves with mesh numbers 18, 20, and 30. The powder retained on each sieve was collected and weighed, then the results were recorded and analyzed to determine the particle size distribution. The requirement for the preparation is to have a small amount of fines (<20%) (Wibowo & Rahmawati, 2025). The particle size distribution was calculated using the formula:

$$\frac{Berat\ partikel\ yang\ lolos\ ukuran\ tertentu}{Total\ berat\ sampel} \times 100\%$$

(Amiruddin et al., 2021).

pH test

The pH test was performed by weighing 5 grams of powder, dissolving it in 200 mL of distilled water and stirring until homogeneous. The pH of the solution was then measured using a pH meter or pH indicator paper and the results recorded. A good pH value is between 4 and 7 (Juba et al., 2025).

Evaluation of Preparations

Angle of Repose

The angle of repose test is performed by inserting approximately 25 grams of powder into a granulation flow tester, then flowing the powder through the end of the funnel to form a pile. The height and radius of the powder pile are measured to determine the angle of repose. The test requirements are met if the angle of repose is in the range of 25° > α < 40° (Fadhila et al., 2022). The angle of repose formula is:

$$\tan\emptyset = 2\ r/h$$

Information:
Ø = angle of repose
h = height of powder spill
r = radius of powder spill

Flow Time

Flow time testing is carried out by weighing 20 grams of powder, then putting it into the flow rate tester.. The time required for the powder to flow is measured using a stopwatch, then the results are recorded. The requirement for a good preparation is to have a fast flow time, namely ≤10 seconds (Handayani*et al.*,2022).

Water content

Water content testing is carried out by weighing 1-2 grams of powder, then placing it in a moisture analyzer cup. The temperature of the tool is set at 105 °C, then the water content is measured and the results are recorded. The water content requirement for effervescent powder or powdered drinks is less than 3% (Janah et al., 2025).

Late Time

The dissolution time test was performed by weighing 2 grams of powder and then adding it to 20 mL of cold water in a glass. The powder was stirred continuously until dissolved. The dissolution time was measured using a stopwatch and recorded. If the powder was declared completely dissolved, the results were then compared with the requirements. A good preparation requires a dissolution time of less than 5 minutes (Husnani & Zulfitri, 2022).

Bulk Density and Tap Density

Density testing was performed by weighing approximately 30 grams of powder and then placing it in a volumetric flask. Powder was added until a volume of 50 mL was reached, weighing each addition. The weight and volume were recorded, and the bulk density meter was then activated for 5 minutes. After the tapping process was complete, the density was calculated. A good dosage form should have a density value in the range of 0.3–0.7 g/mL (Zakaria et al., 2020).

Bulk density: $\frac{Bobot\ serbuk\ (gram)}{Volume\ serbuk\ (mL)}$

Tapped density: $\frac{Bobot\ serbuk\ (gram)}{Volume\ mampat\ (mL)}$

%Compressibility: $\times 100\% \frac{Bulk\ density - Tapped\ density}{Bulk\ density}$

Husner ratio: $\frac{Tapped\ density}{Bulk\ density}$

RESULTS AND DISCUSSION

In this study, a powder formulation containing 10% ascorbic acid (vitamin C) and 1.1% zinc sulfate monohydrate was created to evaluate the feasibility of the preparation (Febriyani et al., 2023). Various ingredients were used in the formulation, such as citric acid as a flavor enhancer, maltodextrin as a filler, aerosil as a glidant, and sucrose and saccharin as sweeteners to improve the palatability of the preparation (Lambros et al., 2022). During the manufacturing process, an in-process control evaluation was carried out, including organoleptic, particle size, particle size distribution, and pH (Asherlia et al., 2024). Then, an evaluation of the final preparation was carried out, including tests on flow time, water content, angle of repose, dissolution time, bulk density, tap density, and compressibility to ensure the quality and suitability of the preparation to the specified requirements (Handayani et al., 2022).

In Process Control

Organoleptic Test

Organoleptic tests are carried out to directly assess the characteristics of the preparation including color, aroma, shape, and taste (Zaddana et al., 2021).

Table 1. Organoleptic Test Results

Results			Condition
Form	**Color**	**Smell**	
Fine Powder	White	Odorless	White in color, powder form, distinctive odor/odorless (Ministry of Health of the Republic of Indonesia, 2020)

Based on the test results, the instant vitamin C and zinc drink powder produced a white color, fine powder form, odorless, and has a sweet and slightly sour taste. The white color of the preparation is influenced by the formulation components which are generally predominantly white. The absence

of aroma in the preparation is due to the ingredients used do not produce a strong aroma. The sweet taste is produced by a combination of sucrose and saccharin as sweeteners, while the slightly sour taste comes from citric acid and vitamin C in the formula. The fine powder form is influenced by the mixing process and the addition of aerosil as a glidant that prevents clumping (Dewi et al., 2025). Based on the specified requirements, namely the preparation is white, in powder form, and has a distinctive odor or is odorless (Ministry of Health of the Republic of Indonesia, 2020), the results of the organoleptic test of this preparation are declared to meet the requirements.

Particle Size Test

Particle size testing was carried out using a multi-stage sieving method with mesh 18, 20, and 30 to determine the particle size of the powder preparation (Anisa et al., 2025).

Table 2. Results of the Particle Size Test of Vitamin C + Zinc Sulfate Monohydrate Powder

Photo	Results	Condition
	0.7795 mm	The particle size of the powder preparation does not exceed 1 mm. (Anisa et al., 2025).

Based on the test results, the data obtained that the powder retained on mesh 18 was 0 grams, on mesh 20 was 0.45 grams, and on mesh 30 was 0.15 grams, with a total weight of the analyzed powder of 0.60 grams. From the calculation results, the average particle size was 0.7795 mm. Based on the requirements for the particle size test of powder preparations, which is less than 1 mm (Anisa et al., 2025), the results of the particle size test of the instant vitamin C and zinc drink powder preparation were declared to meet the requirements.

Particle Size Distribution Test

The particle size distribution test was carried out to measure the distribution of particle size in powder preparations using three sieves arranged sequentially from the coarsest at the top (Aji & Sutiswa, 2025).

Table 3. Results of the Particle Size Distribution Test of Vitamin C + Zinc Sulfate Monohydrate Powder

Photo	Results			Condition
	Mesh 18	Mesh 20	Mesh 30	
	100%	95.5%	94%	Has a small amount of fines (<20%) (Wibowo & Rahmawati, 2025).

Based on the test results, the percentage of fines obtained at mesh 18 was 100%, at mesh 20 was 95.5%, and at mesh 30 was 94%. These values indicate that most of the powder particles were so small that almost all of them passed through the three sieves. Based on the requirements, a good powder should have a fines content of less than 20% (Wibowo & Rahmawati, 2025), so the results of

the particle size distribution test on this preparation were declared to be ineligible. The high number of fines in this preparation is likely related to the zinc sulfate monohydrate sieving process which only used a 40 mesh due to limited equipment in the laboratory, while in general zinc sulfate is sieved using a 60–80 mesh to obtain a more uniform particle size. In addition, the condition of zinc sulfate which tends to clump during sieving also affects the uniformity of particle size distribution in the preparation (Nijhu et al., 2024).

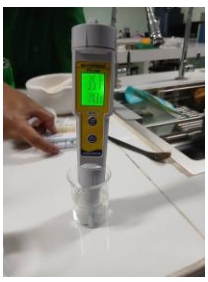
pH test

The pH test is carried out to determine the acidity level of the preparation so that its safety can be ensured when consumed.

Table 4. Results of pH Test of Vitamin C Powder Indicator + Zinc Sulfate Monohydrate

Photo	Results	Condition
	3	pH 4–7 (Juba et al., 2025)

Table 5. Results of pH Meter Test of Vitamin C Powder + Zinc Sulfate Monohydrate

Photo	Results	Condition
	3.57	pH 4–7 (Juba et al., 2025)
	3.57	pH 4–7 (Juba et al., 2025)

Based on the test results, the pH value obtained on the indicator paper was 3 and on the pH meter was 3.57. These pH values indicate that the preparation is acidic, which is influenced by the presence of vitamin C and citric acid in the formulation. Based on the pH test requirements for instant powdered vitamin C and zinc drinks, which are in the range of 4–7 (Juba et al., 2025), the pH test results for this preparation are declared to not meet the requirements. However, the pH value obtained is still within the acceptable pH range for the stomach, namely 3–6, so the preparation is still safe for consumption. Preparations containing vitamin C should be consumed after meals to avoid causing stomach irritation, especially at high doses (Suryaningsih et al., 2021). To increase the pH value to meet the requirements,

optimization can be carried out by reducing the citric acid concentration or adding an appropriate pH regulator to the formulation.

Evaluation of Preparations

Flow Time Test

The flow time test was conducted to determine the flowability of the powder mass, which can affect the uniformity of the dosage form's weight, resulting in uniform filling into capsules or sachets (Rahayu & Anisah, 2021). The results of the flow time test can be seen in Table 6 below.

Table 6. Results of Powder Flow Time Test

Photo	Results	Condition
	10 seconds	≤ 10 seconds (Handayani et al., 2022)

In testing the flow properties of powder preparations, a flow time of 10 seconds was obtained. This value indicates that the water properties of the powder have met the specified requirements, namely ≤ 10 seconds (Handayani et al., 2022), so the powder can be categorized as having good flowability. Powder flow rate is influenced by several factors, including particle size and shape, particle size distribution, hardness level, and particle surface area. Smaller particles generally have greater cohesive forces between particles, making it easier to form agglomerates or clumps that can slow the flow process. In addition, flow rate is also related to the angle of repose; the faster the powder flows, the smaller the angle of repose formed (Rohmani & Rosyanti, 2019).

Water Content Test

Moisture content testing is performed to ensure stability, prevent clumping, and maintain product quality during storage (Husnani, 2022). The results of the moisture content test can be seen in Table 7 below.

Table 7. Results of Powder Water Content Test

Photo	Results	Condition
	2.73%	< 3% (Janah et al., 2025)

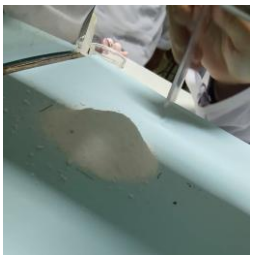
The moisture content test of the powder obtained a value of 2.73%. This value indicates that the moisture content of the powder has met the requirements set out in the literature, which is less than 3% (Janah et al., 2025), so it can be categorized as having a good moisture content and in accordance

with the established standards. These results indicate that the drying process carried out has been optimal in producing powder with a low moisture content. Low moisture content plays an important role in maintaining product stability during storage and reducing the risk of microorganism growth, and can maintain the physical properties of the powder such as preventing clumping and maintaining good powder flowability. Controlling moisture content is a very important factor in maintaining powder quality, both during the production process and storage (Janah et al., 2025).

Angle of Repose Test

The angle of repose test is carried out to determine the flow properties of granules or powder based on the results of the tan calculation.$\emptyset = 2\ r/h$(Solikhati et al., 2022). The results of the angle of repose test can be seen in Table 8 below.

Table 8. Angle of Repose Test Results

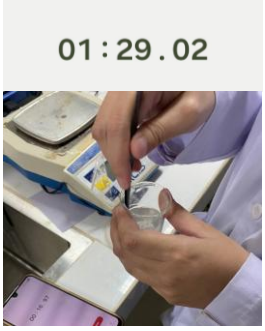
Photo	Results	Condition
	α =31.52º	Fulfills the requirements if 25º > α < 40º (Fadhila et al., 2022)

In the angle of repose test, a pile of powder with a height of 2.5 cm and a diameter of 4.075 cm was obtained, resulting in an angle of repose of 31.52º. This value indicates that the angle of repose has met the requirements, namely 25º > α < 40º and can be categorized as having fairly good flow properties (30º-40º) (Fadhila et al., 2022). However, during testing using a flow tester, the powder did not flow slowly but instead accumulated and came out in large quantities at once, which indicates that the water properties of the powder were not yet classified as good even though the calculations still showed a fairly good category, good flow properties describe the ability of particles to not experience clumping or consolidation and to be able to flow due to the influence of gravitational forces (Utami et al., 2022). The angle of repose value is influenced by several factors, including water content, frictional forces, and interparticle tensile forces and particle size. Powder with low water content tends to form lower piles so that the angle of repose becomes smaller (Rustiani et al., 2024). However, the results of observations show that the powder accumulates and is difficult to flow which can be caused by the hygroscopic nature of the powder, in addition, the smaller the friction and attraction between particles, the lower the resulting angle of repose will be, while smaller particle size can reduce the flow rate thereby increasing the angle of repose (Anastasia et al., 2022). A high angle of repose can cause a decrease in the flowability of the powder which has an impact on the distribution and density of the preparation becoming less even (Rustiani et al., 2024).

Dissolution Time Test

The dissolution time test was conducted to determine the time required for the powder to dissolve in water, thus ensuring ease of use and availability of the active ingredient (Husnani & Zulfitri, 2022). The results of the dissolution time test can be seen in Table 9 below.

Table 9. Results of Dissolution Time Test

Photo	Results	Condition
	1 minute 29 seconds	< 5 minutes (Husnani & Zulfitri, 2022)

The dissolution time test for the powder preparation yielded a powder dissolution time of 1 minute and 29 seconds. These results indicate that the powder dissolution time meets the requirements set in the literature, which is less than 5 minutes (Husnani & Zulfitri, 2022), so the resulting powder has good water dissolution ability. The speed of powder dissolution time is influenced by several factors, such as particle size, particle surface area, and the solubility properties of the material used. Smaller particles generally have a larger surface area, which can accelerate the dissolution process. Therefore, the physical characteristics of the powder play a significant role in determining the speed of the powder to dissolve in water.

Bulk Density and Tap Density Test

Bulk density and tap density tests are conducted to determine the density of a preparation to ensure storage efficiency and compressibility (Supriyanto et al., 2022). The results of the bulk density and tap density tests can be seen in Table 10 below.

Table 10. Bulk Density and Tap Density Tests

Photo	Results	Condition
	a. Bulk Density Value 0.64 b. Tap Density Value 0.72 c. Hausner ratio 1.12 d. Compressibility Index 11.11%	Bulk density: 0.3 - 0.7 (Zakaria et al., 2020) Hausner Ratio: 1.12 - 1.18 (Good) Compressibility Index: 11% - 15% (Good) (Dewi *et al*., 2025)

Table 11. Compressibility Index and Hausner Ratio Parameters

Carr Index (%)	Powder Flow	Hausner ratio
1-10	Very good	1.00-1.11
11-15	Good	1.12-1.18
16-20	Enough	1.19-1.25
21-25	Not enough	1.26-1.34
26-31	Bad	1.35-1.45
32-37	Very bad	1.46-1.59
>38	Very bad indeed	>1.60

In the density test, the bulk density value was obtained at 0.64 g/mL, which indicates that this value has met the requirements in the range of 0.3-0.7 g/mL (Zakaria et al., 2020), and the tap density value was 0.72 g/mL. The density value is known to affect the water properties of the powder, the higher the density value, the better the powder's flowability, which is also supported by the calculation of the hausner ratio (tap density/bulk density) of 1.12 which indicates that the powder has good flow properties (1.12-1.18) (Dewi et al., 2025). In addition, the calculation of the compressibility index obtained a value of 11.11%, which indicates that the powder has good compressibility according to the range of 11%-15%, the compressibility is influenced by the tap density value and the level of powder compression (Dewi et al., 2025). Low bulk density values can cause bulkiness (Tambunan et al., 2025). This is influenced by several factors such as particle size and shape, smaller particles tend to form masses with greater density, while particles with irregular shapes have smaller bulk density values due to the presence of cavities between particles filled with air, so that powder with good bulk density will be easier to store because it requires a smaller volume (Prasesti et al., 2016).

CONCLUSION

The combination of vitamin C and zinc powder has met most of the evaluation test parameters, including organoleptic, particle size, flow properties, water content, angle of repose, dissolution time, and compressibility. However, the preparation has not met the requirements for particle size distribution and pH. Thus, the formulation used is not optimal and still requires several improvements to ensure the preparation meets all the requirements for the powder evaluation test. The author would like to thank the Faculty of Medicine, Semarang State University for providing the facilities for the author to conduct this research.

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