# OPTIMIZATION OF ARTHROSPIRA PLATENSIS SUSPENSIONS: EVALUATING THE INFLUENCE OF SUSPENDING AGENT VARIATIONS ON PHYSICAL STABILITY

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## Abstract

*Arthrospira platensis* is one of the microalgae rich in protein, vitamins, minerals, and antioxidants, making it a promising raw material for the formulation of pharmaceutical and nutraceutical products. This research aims to develop a suspension formulation from *Arthrospira platensis* powder that meets the physical properties of a suspension formulation and to determine a good formulation for *Arthrospira platensis* powder suspension by modifying the formulation regarding the concentration of the suspending agent used. The research methods include formulating suspensions using various types of materials and evaluating their physical stability (organoleptic properties), viscosity, pH, solution density, and sedimentation. Suspension preparations of *Arthrospira platensis* powder were made using 3 formulas with varying concentrations of CMC-Na as a suspending agent. The concentrations for each formula were: Formula I (0.25%), Formula II (0.5%), and Formula III (1%). Results: Based on the research and the results obtained, the viscosity values using spindle No. 2 and a speed of 20 were: Formula I 278.5 cp, Formula II 352 cp, and Formula III 401.5 cp. Therefore, the viscosity obtained for Formula II was better compared to Formula I and Formula III. The formulation of *Arthrospira platensis* powder suspension using CMC-Na as a suspending agent affects the viscosity of the preparation. The higher the concentration of CMC-Na used, the higher the viscosity of the suspension preparation.

Keywords : Arthrospira platensis, spirulina, proteins, stunting, suspension.

## 1. INTRODUCTION

Stunting is a condition where children under five are shorter than expected for their age. Stunting can be identified in children under five if their height has been measured and compared to standards, with the results being below normal. The standard used is the World Health Organization – Multicentre Growth Reference Study in 2005, with short stature categorized as a z-score of -2 SD (Standard Deviation) and very short stature categorized as a z-score of -3 SD[1].

The consequences of stunting in toddlers can affect their growth and development, one of which is disrupting the child's height and weight gain, making the child tend to be shorter with a weight far below the average for their age[2]. Then, suboptimal child growth and development also cause children to walk late or have less than optimal motor skills, which can affect the child's low IQ and thus impact their learning ability. Therefore, it can be concluded that stunting impacts children's physical and cognitive development[3].

There are several food items that are high in protein, both animal and plant-based. One source of protein with a high protein content is the alga Arthrospira Platensis. The plant Arthrospira Platensis is a marine organism with many beneficial properties. This can be seen from the use of Arthrospira Platensis to create various medicinal preparations and through modern scientific knowledge. The content of Arthrospira Platensis can be scientifically proven. Arthrospira Platensis is a marine organism that is rich in protein, containing 50-70% depending on its source . The vitamins it contains are vitamins B1, B2, B3, B6, B9, B12, antioxidant sources like Vitamin C, Vitamin D, and Vitamin E, and also a source of potassium, calcium, chromium, copper, iron, magnesium, manganese, phosphorus, selenium, sodium, and zinc [4],[5].

Suspension formulations are created because some active drug substances have practical insolubility in water, yet are needed in liquid form for easy administration to patients who have difficulty swallowing, for easy administration to children, and to mask the bitter taste and unpleasant odor of the active drug substance[6]. This is consistent with the characteristics of Arthrospira Platensis, which has a distinctive aroma and taste. This distinctive aroma and taste can be masked by adding sugar, in this case fructose, and adding flavorings such as lime essence. Additionally, because water is the safest solvent for humans, it is used as the carrying medium in most suspension preparations. Although the active ingredient of the drug has poor water solubility, it can still be formulated into a liquid dosage form with the aid of a suspending agent[7].

## 2. METHODOLOGY

### 2.1 Extract & Chemicals

Arthospira Platensis extract powder from Albitec, Semarang, West Java, Indonesia. Other than those already specified, the laboratory chemicals utilized in the investigation were of the analytical reagents grade and several types of equipment employed in the formulation of herbal suspension were.

### 2.2 Formulation of Suspension

Arthrospira Platensis powder was made with variations of 0.5%, 0.75%, and 1% suspending agent. Based on the nutritional adequacy figures from the Indonesian Ministry of Health Regulation No. 28 of 2019, the protein requirements for children vary: 20 grams for children aged 1-2 years, 25 grams for children aged 4-6 years, and 40 grams for children aged 7-9 years. Based on the data above, the dosage of Arthrospira Platensis powder used was determined to be 35g/150 ml solution. This dosage is able to provide children with a protein requirement of 22.75 grams. Therefore, a suspension was made with a volume of 150 ml, with each 15 ml of solution containing 3.5 g of Arthrospira Platensis powder and 2.27 g of protein, to be taken once a day, 1 tablespoon at a time. (Ministry of Health Regulation of the Republic of Indonesia, No. 28 of 2019)

**Table 1**. *Working Formula for Arthrospira Platensis Suspension*

| No | Compound | Formula 1 (F1) | Formula 2 (F2) | Formula 3 (F3) | Range | Function |
|---|---|---|---|---|---|---|
| 1 | *Arthrospira Platensis extract* | 35 g | 35 g | 35 g | 23,3 % | Active Compound |
| 2 | CMC-Na | 0,375 g (0,25%) | 0,75 g (0,5%) | 1,5 g (1%) | 0,25 - 1 % | Suspending Agent |
| 3 | Fructose | 75 g | 75 g | 75 g | 50 % | sweetener |
| 4 | *Propyleneglycole* | 7,5 g | 7,5 g | 7,5 g | 5% | *wetting agent* |
| 5 | Lime Essence | 6 ml | 6 ml | 6 ml | 4% | Flavouring agent |
| 6 | Benzoic Sodium | 0,15 g | 0,15 g | 0,15 g | 0,1% | Preservative |
| 7 | Aquadest | Ad 150 ml | Ad 150 ml | Ad 150 ml | - | Pengisi |

### 2.3 Evaluation of Suspension Formulation

#### 2.3.1 Organoleptic Test

The test was conducted on the test suspension preparation for 7 days using organoleptic methods. The observations made in this test are the color, odor, and taste of each preparation. Success in the

organoleptic test means that there are no physical changes in each test preparation in terms of color, odor, and taste[8].

### 2.3.2 Measurement of pH

The pH test was conducted using a pH meter as an instrument to indicate the pH value after the instrument was dipped into each preparation. This test began by pouring each preparation into separate beakers, then dipping the pH meter and allowing it to sit until the pH meter showed a constant pH value. A good pH value for suspension preparations is pH 4-7[9].

### 2.3.3 Measurement of Viscosity

The purpose of the viscosity test is to determine how thick the tested preparation is. This test began by preparing each test sample and then pouring it into a 100 mL beaker. After that, the spindle was dipped into the beaker containing the test sample until it reached the mark on the spindle. Then the testing instrument began to work and showed the viscosity values for each test preparation. The appropriate viscosity value according to SNI is 38-396 cp[9].

### 2.3.4 Measurement of Density

Density is measured using a pycnometer. At room temperature, the dry and clean pycnometer is weighed (A grams). Then it is filled with water and weighed again (A1 grams). The water is removed from the pycnometer and the pycnometer is cleaned. Then the suspension was filled into the pycnometer and weighed (A2 grams). The density of the preparation is calculated using the following equation: Density = A2 - A : A1 - A. The density of a suspension with a good water carrier is >1.00[10].

### 2.3.5 Measurement of Sedimentation Volume

Test The sedimentation rate was measured by comparing the time it took for sedimentation to occur in three formulations. According to Physical Pharmacy, the criteria for a good suspension are that the dispersed substance should not settle quickly. Good redispersibility means the suspension is perfectly dispersed when shaken by hand for a maximum of 30 seconds[11].

## 3. RESULTS AND DISCUSSIONS

### 3.1 Results of Organoleptic Testing Observation

**Table 2.** The Results of Organic Evaluation.

| Formulation Code | Color | Smell | Taste |
|---|---|---|---|
| F1 | Green | Orange Flavour | Sweet |
| F2 | Green | Orange Flavour | Sweet |
| F3 | Green | Orange Flavour | Sweet |

The formulation of Arthospira Platensis suspension did not undergo any organoleptic changes. There is a distinctive aroma from Arthospira Platensis, a blend of sweet and bitter flavors with lime essence, but in Formula 2, the sweetness and fishy aroma of Arthospira Platensis can be masked by the lime essence, and the suspension has a dark green color[7],[8].

### 3.2 Results of pH Test of Arthrospira Platensis Suspension

**Table 3**. *The Results of pH Measurement*

| Formulation Code | F1 | F2 | F3 |
|---|---|---|---|
| pH | 6,1 | 6,39 | 6,16 |

The three formulations did not show any organoleptic changes on the seventh day. The pH test evaluation for the three formulations was the same, ranging between 5-6 on the pH meter. However, among the three formulas, the second one had good pH stability compared to the others, with the first and third formulas experiencing a significant decrease in pH. Therefore, all three formulas still meet the ideal pH requirements for suspensions, which is in the range of 4-7[9],[11].

### 3.3 Viscosity Test Results of Arthospira Platensis Suspension

**Table 4**. *The Results of Viscocity Measurement*

| Formulation Code | F1 | F2 | F3 |
|---|---|---|---|
| Viscosity | 235,7 cps | 358,1 cps | 397,4 cps |

Testing the viscosity of a suspension is a very important test for the stability and pourability of the suspension. As the viscosity of the suspension increases, the sedimentation rate of the solute decreases, which can slow down the sedimentation process of the suspension preparation. Additionally, as the viscosity of the suspension increases, its pourability decreases and the discomfort of consuming the suspension increases. Thus, the viscosity of the suspension must be maintained within an optimal range to produce a stable and pourable suspension. According to SNI, the viscosity value of a good suspension falls within the range of 38cp - 396 cps. Formulations 1 and 2 have viscosity values within the specified range. This indicates that the viscosity of the preparation has met the established requirements. However, in the third formula, the viscosity value exceeded the established range, which is between 397 – 401 cp. This occurred because of the variation in the suspending agent, CMC-Na, which was used in excess, at 1% or 1.5 g. Therefore, the suspending agent needed to be reduced to achieve better viscosity [9], [11]

### 3.4 Results of Density Test for Arthospira Platensis Suspension

**Table 5**. *The Results of Density Measurement*

| Formulation Code | F1 | F2 | F3 |
|---|---|---|---|
| Density | 1,02 g/cm$^3$ | 1,04 g/cm$^3$ | 1,12 g/cm$^3$ |

The density of the Arthospira Platensis suspension was calculated using a pycnometer. The weight of each Suspension formulation was measured using a pycnometer. Before doing this, the empty pycnometer was weighed and found to have a weight of 23.84 g. Then, distilled water was added to the pycnometer, and the weight was found to be 49.55 g. In this case, distilled water was used as a standard with a density of 1. The weight of each formulation and distilled water weighed was 50 ml. The weighing results for the three formulations were 50.65, 51.73, and 55.86, respectively. Next, from these two data sets, the density of the suspension was obtained from formula one as 1.02, formula two as 1.04, and formula three as 1.12. From the measurement results, it was found that each formulation met the criteria for a good water-based suspension, which is >1.00[10].

### 3.5 Results of Sedimentation Volume Test for Arthospira Platensis Suspension

***Table 6.*** *The Results of Sedimentation Volume Measurement*

| Formulation Code | *Sedimentation Volume ( Day)* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* | *7* |
| *F1* | *0,8* | *1,2* | *1,6* | *1,9* | *1,8* | *1,7* | *2,0* |
| *F2* | *-* | *-* | *0,3* | *0,5* | *0,3* | *0,3* | *0,5* |
| *F3* | *-* | *-* | *-* | *-* | *0,1* | *0,3* | *0,2* |

The final test is the evaluation of the Arthospira Platensis suspension sedimentation test. Observations were made for 7 days. On the first day, only the first of the three formulations showed sedimentation, which was 0.8 cm, while the second and third formulations did not show any sedimentation. By the seventh day, sedimentation occurred in all suspension formulations: 2 cm in the first formulation, 0.5 cm in the second, and 0.2 cm in the third. These data indicate that Formulations 2 and 3 have good solubility, disperse well when shaken for 30 seconds, and do not easily settle within more than 30 minutes . The solubility in Formulation 1 was less good, sedimentation occurred more quickly, and it did not disperse well when shaken for 30 seconds. The opposite also occurred with the third formulation, which was too thick, making the suspension solution difficult to pour. After all tests were conducted on all formulas, including the first, second, and third formulas, the results showed that the second formulation had better results compared to the others, in terms of organoleptic tests, pH tests, viscosity tests, density tests, and finally, sedimentation tests[11].

## 4. CONCLUSSION

4.1. Arthospira Platensis powder can be formulated into a suspension preparation that meets the physical requirements of the preparation.

4.2.Variations in CMC-Na as a suspending agent affect the physical properties of the preparation, with the most influenced properties being the viscosity and sedimentation rate of the suspension preparation.

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## REFERENCES

[1] S. Santriawati and A. Moesri, “CASE REPORT Impact of stunting on child growth and development measured by the denver developmental screening test: a case report,” Intisari Sains Medis | Intisari Sains Medis, vol. 16, no. 3, pp. 1127–1131, 2025, doi: 10.15562/ism.v16i3.2509.

[2] R.R Akbar, W. Kartika, M. Khairunnisa, “ The Effect of Stunting on Child Growth and Development “, Scientific Journal, vol. 2, no. 4, pp. 153-159, 2023. [Online]. Avalaible :www.journal.scientific.id.

[3] M. R. D Mustakim, R. Irawan, M. Irmawati, and B. Setyoboedi, “Impact of Stunting on Development of… Impact of Stunting on Development of Children between 1-3 Years of Age,” Ethiop J Health Sci, vol. 32, no. 3, p. 569, 2022, doi: 10.4314/ejhs.v32i3.

[4] A. Vaishnavi and K. Rachana, “‘FORMULATION AND EVALULATION OF HERBAL SPIRULINA PLANTENSIS SYRUP FOR GUT MICROBIOTA HEALTH,’” 2025. [Online]. Available: www.ijnrd.org

[5] N. Begum et al., “Nutritional Composition and Functional Properties of A. platensis-Derived Peptides: A Green and Sustainable Protein-Rich Supplement,” Nov. 01, 2024, Multidisciplinary Digital Publishing Institute (MDPI). doi: 10.3390/pr12112608.

[6] O. Boscolo, F. Perra, L. Salvo, F. Buontempo, and S. Lucangioli, “Formulation and Stability Study of Omeprazole Oral Liquid Suspension for Pediatric Patients,” Hosp. Pharm., vol. 55, no. 5, pp. 314–322, Oct. 2020, doi: 10.1177/0018578719844704.

[7] L. V Kulkarni, V. B. Metkari, G. S. Bamane, P. A. Jadhav, and G. S. Raut, “Recent Trends on Achieving Taste Masking of Bitter Drug,” 2014. [Online]. Available: www.jcpronline.in

[8] M. S. Khan and M. S. Rahman, Techniques to measure food safety and quality: Microbial, chemical, and sensory. Springer International Publishing, 2021. doi: 10.1007/978-3-030-68636-9.

[9] Afnan KV, Jamsheer KA, Safa Muhammed P, and Raheena KA, “Formulation and evaluation of herbal nanosuspension of Scoparia dulcis,” World Journal of Biology Pharmacy and Health Sciences, vol. 13, no. 1, pp. 339–343, Jan. 2023, doi: 10.30574/wjbphs.2023.13.1.0055.

[10] G. Sharif, “The Role of Liquid Density in Pharmaceutical Formulation and Quality Control,” 2024, doi: 10.4172/2320.

[11] H. Pratisha Bibhishan, M. S. A. Ghadage, and S. Jain, “A REVIEW ON PHARMACEUTICAL SUSPENSION,” 2023. [Online]. Available: www.ijcrt.org