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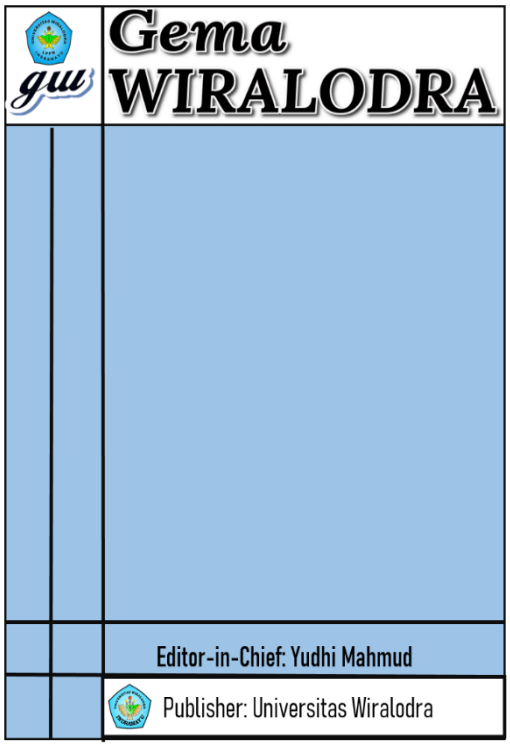

Formulation of Red Spinach and Celery Jelly Candy as Functional Food Innovation and Stunting Prevention

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Formulation of Red Spinach and Celery Jelly Candy as Functional Food Innovation and Stunting Prevention

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Abstract
Stunting is a child growth disorder due to unmet nutritional requirements (RDA) starting from the growth period in the foetus until the age of 2 years. Functional food innovation, jelly candy, is an alternative to prevent stunting and supports the effective use of natural ingredients, such as red spinach and celery. The purpose of this study was to analyse the best formula of red spinach and celery as raw materials for jelly candy and its effectiveness for stunting prevention. The research method is experimental jelly candy formula with 3 variations of raw material concentration, namely F1 (10:0.7), F2 (12:0.78), and F3 (14:0.86), and analysing formula variations with several analytical methods, namely vitamin C and iron tests using iodimetric and permanganometric titration methods, moisture content test using gravoimetric method, pH test using pH meter, and organoleptic test. The results of the research analysis showed that the physical and chemical characteristics of the formula met the quality standards of jelly candy. The physical characteristics of each formula showed normal colour and scent, chewy texture, sweet taste, moisture content ≥ 20%, and pH 7. The chemical characteristic showed that the higher the concentration of spinach and celery leaves, the higher the levels of vitamin C and iron content. The vitamin C content F1 = 11; F2 = 18; F3 = 22mg, and iron content F1 = 26; F2 = 34; F3 = 26mg. Based on the results obtained, it is concluded that F2 is the best formula effective formula used to prevent stunting by fulfilling the RDA for pregnant women and toddlers.
Keywords: Functional Food, Stunting, Jelly Candy, Red Spinach, Celery.

1. Introduction

Stunting is one of the health disorders in children that causes the growth of children not in accordance with the growth standards of children their age. Stunting can be categorised as a disease that is quite synonymous with malnutrition or not fulfilling the Recommended Dietary Allowances (RDA) starting from the growth period in the fetus until the age of 2 years. Based on data on stunting cases by Health Ministry, 2022, the stunting rate in Indonesia is 21.6% and by 2023 it will be 27.2%. The stunting data shows the high presence of stunted children in Indonesia. According to WHO standards, which state that the number of stunting cases should be below 20%, stunting in Indonesia needs to be addressed specifically and immediately (Ahmad et al., 2023).

The cause of stunting is malnutrition, which starts from the fetal growth period in the mother's womb until the age of 2 years old (Sitorus., 2024). Handling stunting can be done in several ways, one of them namely providing nutritious food or fulfilling the nutritional adequacy of toddlers and pregnant women (Siswati et al., 2024). Nutritional adequacy can be met through the use of functional foods, especially during the growth period of toddlers.

Functional food is food that has added value, one of which is nutritional value, in addition to its role as food. This supports the role of functional food as the best alternative for toddlers

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because toddlers as consumers require special handling related to interest in food that has adequate nutrition. Food with sufficient nutritional value generally has less desirable organoleptic characteristics so that innovation in food products is needed so that it can attract consumer interest. According to Hastuti et al., 2024, and Nofrida et al., 2023, functional foods are effective in reducing stunting rates and are in demand by consumers. Proper innovation of functional food can support the function of functional food as an alternative to stunting prevention.

Functional food innovations can be found in a variety of innovations such as flour, cakes, candy, milk, and several other variations. Jelly candy is one of the competent innovations and is quite attractive to toddlers and pregnant women. The selection of the right raw materials for jelly candy, namely raw materials that have high nutritional value, will support the effectiveness of jelly candy as functional food for stunting prevention.

Based on the RDA standards in PermenKes No. 28, 2019, it can be seen that iron and vitamin C are one of the micronutrient groups that need to be fulfilled for the growth of toddlers aged 0-2 years. Food sources with the best micronutrient values can be obtained from fruits and vegetables and proper processing of these food sources can increase the functional value of these foods.

According to Sagala et al., 2024 and Dewi et al., 2024, plants or vegetables red spinach (Amarantus tricolor) and celery (Apium graveolens), especially in the leaves, are types of plants that thrive in Indonesia and are a source of vitamin C and iron. According to Albab et al., 2023, the iron and Vitamin C content in 100 grams of celery leaves is 1 gram and 11 mg. According to Novianti et al., 2023, the iron and vitamin C content in 100 grams of red spinach leaves is 7 mg and 62 mg.

The utilised as functional food for toddlers and the general public is still lacking because it has organoleptic characteristics, especially the taste that is less desirable. The utilisation of red spinach and celery as jelly candy is one of the best innovations for its role as functional food. This study aims to analyse the best formula for the innovation of red spinach and celery as raw material for functional food (jelly candy) and the effectiveness of jelly candy for stunting prevention.

2. Method

This study aims to find out the concept and performance of development planning policies through the Development Plan Consultation (Musrenbang) so far, as well as problems and solutions in the future. This study uses a descriptive research method with a qualitative approach and uses a literature study. Data and information were collected from various relevant literatures and analyzed qualitatively to facilitate discussion and then to draw a conclusion.

3. Results and Discussion

Results

The research was conducted in the Integrated Laboratory and used the main ingredients of red spinach and celery leaves in Makale, Tana Toraja. The equipment used were oven, desiccator, calibrated pH meter, and titration equipment. The type of research to be used is experimental research using 4 samples Tested of Jells Candy, namely a positive control of jelly candy (without the addition of red spinach and celery leaf essence) and replication 3 times. The experimental research aims to develop a jelly candy formulation from a combination of celery leaves (*Apium graveolens*) and red spinach leaves (*Amaranthus tricolor*). The research stages are divided into 4 core parts, namely the preparation of red spinach leaf juice and celery leaves, formulation of red spinach leaves and celery leaves in making jelly candy, evaluation/analysis of jelly candy preparations, analysis of jelly candy preparation evaluation data.

p-ISSN: **1693-7945**
e –ISSN: **2622 - 1969**

Orginal Article

3.1 The Preparation of Red Spinach Leaf Juice and Celery Leaves

The process of making one of the plant juices, namely red spinach essence, can be seen in Figure 1. The process is one of important stages that determine the nutrition quality of jelly candy.

Figure 1.
Stages Of The Process Of Making Red Spinach Leaf Juice

Figure 1 showed that the preparation of spinach leaf and celery leaf essence begins with sorting red spinach leaf vegetables and celery leaves, then knitted/cut separately. Red spinach leaves and celery leaves were weighed as much as 200 grams each, then washed. Clean spinach leaves and celery leaves were mixed with water with a ratio of leaves and water of 2:3 for each celery leaf and spinach leaf. After adding water, the next stage of each mixture is homogenised and mashed using a blender, then each mixture is filtered using a filter with a small mesh. The filtrate of red spinach leaves and celery leaves obtained is stored and ready to be processed for the next stage. Blending and adding water (water ratio) are processes that control the quality of red spinach and celery Essence.

3.2 Formulation of Red Spinach Leaf and Celery Leaf in Jelly Candy Making

The basic formula of this study refers to the research of Wahyudi et al., 2021, and Ulfa et al., 2024, which state that the addition of red spinach leaves at a concentration of ≥10%b/b and celery leaves at a concentration of <0.78 food samples will provide high levels of nutrients, especially vitamin C and iron. The researched made to modification of the concentration formulation of red spinach and celery leaf jelly candy, the formulation can be seen in table 1 and the stage of process can be seen in figure 2.

Figure 2.
Process Stages of Making Red Spinach and Celery Leaf Jelly Candy

Based on figure 2 showed the initial stage of formulation were mixing dan cooking 500 grams of sugar, 500 mL of water, 2 packets of plain agar, and 2 packets of original nutrijelly while stirring the mixture until homogeneous. Next, the mixture was added with the juice of red spinach leaves and celery leaves according to the formula contained in table 1.

Table 1.

Formulation Concentration Variations of Red Spinach Leaf and Celery Leaf Juice

No.	Essence Plant	Formula (%b/b)	Material Function

p-ISSN: **1693-7945**
e –ISSN: **2622 - 1969**

		F0 (Control)	F1	F2	F3	
1.	Red spinach leaves	0	10	12	14	Active Substance
2.	Celery Leaf	0	0.7	0.78	0.86	Active Substance

The formula mixture (formula that added with variation concentration of active substance in table 1) was heated at a temperature of ± 100˚C while stirring until the formula mixture was homogeneous and thick. After the formula mixture is boiled, the formula mixture is poured into the mould pan and dried at room temperature or with the help of sunlight until the jelly texture of the candy is obtained. The use of high temperatures can cause the texture of the jelly candy to be harder and a charred colour and aroma will be formed. After the whole process is complete, the last step is to pack the jelly candy.

3.3 Evaluation/Analysis of Jelly Candy Preparations and Analysis of Jelly Candy Preparation Evaluation Data.

Evaluation of jelly candy preparation consists of 5 test methods, namely organoleptic testing, pH, vitamin C, iron content, and water content. Each test method applies 3x replication (Triplo). Organoleptic testing uses 30 panelists with test categories, namely colour, odour, and texture (Fransiska, et al, 2023), pH measurement using a pH meter that has been calibrated using pH 4 and 10 buffer solutions, moisture content gravimetric method, namely heating the test sample in an oven at 105˚C then cooling in a desiccator until a constant weight is obtained (AOAC, 2005), iron content permanganometric titration method with dilution treatment of test samples and titration using $KMnO_4$ peniter and H_2SO_4 2N catalyst until a purplish red colour change occurs (the equivalence point has been reached) (Tambunan, et al, 2023), vitamin C content iodimetry titration method with dilution treatment of test samples and titration using 0.01N Iod solution peniter, amylum indicator, and H_2SO_4 2N catalyst until a purplish red colour change occurs (the equivalence point has been reached) (Asmal, et al, 2023).

Discussion

The data or research results obtained from the formulation of celery leaves (*Apium graveolens*) and red spinach leaves (*Amaranthus tricolor*) are divided into 2 parts, namely the evaluation of the physical and chemical properties of jelly candy. Analysis of the physical properties of jelly candy, namely organoleptic, water content, and pH. Organoleptic characteristics of formulas 1, 2, and 3 can be seen in Figure 3. Chemical properties of jelly candy, namely vitamin C and iron levels can be seen in Table 2.

Table 2.
Physical Characteristics of Red Spinach and Celery Jelly Candy

Formula	Color	Organoleptic Scent	Flavour	Texture	pH	Water Content (%)
F1	Greenish white	The distinctive scent of red spinach	Sweet	Chewy	7	14
F2	Red	Red spinach typical aramo + a little celery typical aroma	Sweet	Chewy	7	15
F3	Red brown	Distinctive and concentrated aramo	Very Sweet	Chewy	7	15.2

p-ISSN: **1693-7945**
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	of red spinach + distinctive aroma of celery	

The formulation of celery leaves (*Apium graveolens*) and red spinach leaves (*Amaranthus tricolor*) showed physical characteristics that met the criteria for jelly candy based on SNI 3547.2-2008. The quality standard of jelly candy states that jelly candy has a normal scent and taste standard as well as a chewy texture, and a maximum moisture content of 20%. The results of the study in Table 2 showed that jelly candy from red spinach leaves and celery leaves has a distinctive scent of the plant or can be classified as normal scent and taste because it is in accordance with the aroma of the constituent composition and is an aroma that is not pungent.

Figure 3.
Organoleptic Characteristics Of Formulas 1, 2, and 3

Based on table 2 and figure 3, the difference in aroma and taste in the formula variations shows that the more the concentration of red spinach, the more intense the red colour of the jelly candy and the sweetness of the jelly candy will increase. The association of increasing spinach concentration with sweetness can be caused by the largest constituent component of red spinach, namely carbohydrates of 47% or around 6.3 grams in 100 grams of red spinach (Anjarwati et al., 2023). Glucose is a type of simple sugar that composes carbohydrates so that the carbohydrate content in red spinach can increase the sweetness of jelly candy. The chewy texture of jelly candy shows the composition of additional ingredients in jelly candy, especially the composition of the right chewing agent. The chewy texture of the jelly candy also shows the fulfilment of the quality standards of jelly candy based on SNI 3547.2-2008. Organoleptic characteristics of a food product or drug preparation can increase consumer interest so that the selling value and effectiveness of the use of medicinal preparations in the form of functional food will increase, especially for target consumers, namely pregnant women and toddlers. In addition to organoleptic characteristics, other physical and chemical characteristics are also important factors to increase consumer interest.

Moisture content is one of the characteristics that is quite closely related to the organoleptic characteristics of jelly candy. An appropriate moisture content value (in accordance with SNI 3547.2-2008 standard) of max. 20% supports organoleptic characteristics that are in accordance with the standard, especially in terms of texture quality. Based on Table 2, it can be seen that jelly candy from red spinach leaves and celery leaves has a value below 20% so that the value of water content supports organoleptic characteristics that meet the standard. The increase in water content in the formula variation shows that the higher the concentration of red spinach, the higher the water content of a sample (jelly candy). This is in line with the research of Pustika et al., 2020, which states that the more carbohydrate content of a food ingredient, the more the moisture content of the food ingredient will increase. Low moisture content or meeting product standards can also increase the shelf life of a product so

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that jelly candy can last longer. Based on the data in Table 2, it shows that jelly candy from red spinach leaves and celery leaves has a pH value that is safe for consumption, especially for toddlers as target consumers. A neutral pH can also minimise the reaction or side effects of a candy when processed in the human body.

Table 3.
Chemical Properties of Red Spinach and Celery Jelly Candy

Formula	Iron Content (mg/gram jelly candy)	Vitamin C Content (mg/gram jelly candy)
F0	10	7
F1	26	11
F2	34	18
F3	36	22

The innovation of vegetable plants in the form of jelly candy preparations and the content of vitamin c and iron in red spinach leaves and celery leaves show the potential role of jelly candy as a functional food innovation. The chemical properties of jelly candy formulated from red spinach leaves and celery leaves show the nutritional quality of jelly candy with high enough vitamin C and iron levels to fulfil nutritional adequacy and prevent stunting.

The increase in vitamin C levels in each formula shows that the more the concentration of red spinach and celery leaves, the higher the value of vitamin C levels. This is in line with the high levels of vitamin C in red spinach and celery. Based on data from PermenKes No. 28 of 2019 states that the Recommended Dietary Allowances (RDA) of vitamin C for toddlers 0-2 years is 40 mg / day and for pregnant women is 90 mg / day.

Based on the fulfilment of the nutritional adequacy value and the value of vit. C content in 1 gram of jelly candy, it can be seen that formulas 2 and 3 are the best formulas. However, the data in Table 3 shows that the vitamin C content does not meet the RDA if consumed only 1 gram of candy in a day so it is necessary to determine the quantity of certain candies to fulfil nutritional adequacy. In addition, the innovation of the concentration ratio of red spinach and celery needs to consider the high value of vitamin C content in red spinach so that the concentration of red spinach can be increased.

Other chemical properties studied were iron content. Based on the data in Table 3, it can be seen that the value of iron content in jelly candy is quite high, which is above ± 26-36 mg / jelly candy. This is in line with the very high levels of iron vitamins in celery leaves, which is 1 gram in 100 grams of celery leaves. In addition, high iron levels are also influenced by the addition of agar and nutrijelly, both of which are processed seaweed products. Based on the results of the study it can be seen that the addition of processed grass products to food products will increase the iron content in these food products.

Based on data from PermenKes No. 28., 2019 that the RDA of iron in toddlers 0-2 years for iron is 0.3-7 mg / day and pregnant women are ± 27 mg / per day. Excessive iron consumption can cause side effects for target consumers so further research and innovation is needed to determine the concentration of celery leaves added. The high iron content in celery leaves and the addition of agar and nutrijelly, where these two ingredients are processed seaweed products. Based on the research of Pereira et al., 2024, it can be seen that the addition of processed seaweed products to food products will increase the iron content in these food products.

Heating is one of the processes of making jelly candy that can affect the nutritional quality of the raw materials (spinach leaves and celery leaf). However, the study showed that the

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heating process did not affect the quantity of iron and vitamin c content of the raw materials. This can be seen from the comparison of data on iron and vitamin c content in 100 grams of spinach and celery with data on iron and vitamin c content in jelly candy with red spinach and celery formula.

According to research of Reyes et al., 2024 and Panzeri et al., 2024, it can be seen that vitamin C dan iron nutrition is one of the essential nutrition to ensure the nutrition for toddlers and pregnant women. Therefore, the fulfilment of these nutrients in the right concentration can prevent stunting and improve the quality of child development.

The comparison of vitamin C and iron content values, it can be a reference in determining the concentration of spinach leaves and celery leaves. Celery leaves can be reduced in concentration and spinach leaves added so that the fulfilment of RDA and the nutritional balance of these two micro-molecules in the body can be fulfilled. Based on RDA of iron and vitamin C in toddlers 0-2 years, we can predict that Formula 2 can be one of the formula recommendations of jelly candy because the value of vitamin C concentration is quite good and iron levels are still tolerable compared to other formulas. However, to obtain the accuracy of an effective formula for stunting prevention, we must conduct in vivo effectiveness tests or clinical trials.

5. Conclusion

Based on the results of research on the formulation of red spinach and celery as raw materials for jelly candy, it can be concluded that: (1) Formula 2 is the best formula for innovation of red spinach and celery as a functional food raw material, with organoleptic characteristics that comply with SNI 3547.2-2008 standards, moisture content >20%, pH 7, vitamin C content 18 mg / jelly candy, and iron content 34 mg / jelly candy. (2) Formula 2 jelly candy can be an alternative functional food to increase the effectiveness of stunting prevention but still requires further concentration analysis..

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