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Innovative Alternative Zinc Supplementation for Stunted Children from Pumpkin Seeds in the Form of Gummy Candy

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Abstract: Stunting is a chronic nutritional problem that is a big challenge in Indonesia, with a prevalence of 30.8% in 2018. The main cause of stunting is zinc deficiency, affecting the growth and development of children. Yellow pumpkin seeds are known to be rich in zinc content and can be used as an alternative source of zinc to prevent stunting in children. The purpose of the study is to make an innovation of Gummy Candy zinc yellow pumpkin seeds as an alternative to supplementation in Stunting, To test the evaluation of the physical and safe characteristics of Gummy Candy zinc zinc pumpkin seeds as an alternative to supplementation in stunted children. The research method uses an experimental with a quantitative approach. The results of the evaluation test of the physical characteristics of Gummy Candy preparations were obtained that the preparation has good characteristics seen from the attractive shape, chewy texture, slightly sour and sweet taste. The weight uniformity test did not deviate from the test and the pH test 4 was met for the pH of the Gummy Candy preparation which was 4-5. The zinc level test in the Gummy Candy made showed the presence of zinc contained in the preparation. Conclusion Gummy Candy zinc yellow pumpkin seeds as an alternative to supplementation in stunted children using 2 bases, namely gelatin and carrageenan printed with the shape of a heart, producing a preparation product that can attract children's attention, Giving processed products of yellow pumpkin seeds can increase the status of zinc in children at risk of stunting.

Keywords: Gummy candy; Ph test; Stunting; Weight uniformity test; Zinc level test.

Introduction

Based on data from the National Nutrition Status Survey (SSGI), the prevalence of stunting in Indonesia in 2022 was 21.6% (Kustanto et al., 2024; Laksono et al., 2024; Pratiwi, 2023). This number decreased compared to 2021, which was 24.4%. In 2023, the stunting rate in Indonesia was recorded at 21.5%, a decrease of only 0.1% from the previous year, according to data from the Ministry of Health. This figure is still considered high, with the target stunting prevalence for 2024 set at 14%, and it remains above the standard set by the World Health Organization (World Health Organization, 2023), which is under 20%.

In Indonesia, the government pays significant attention to the issue of stunting, as demonstrated by the Medium-Term Development Plan (RPJMN) 2020–2024. Stunting is one of the chronic nutritional problems that is still a major challenge in public health development (Ali, 2021), especially in developing countries such as Indonesia. Based on data from *the 2022 Indonesian Nutrition Status Survey (SSGI)*, the national stunting prevalence reached 21.6%, still far from the *Sustainable Development Goals (SDGs)* target of 14% by 2024. Stunting not only impacts children's stunted physical growth, but also affects cognitive development, body immunity, and long-term productivity. This condition is generally caused by inadequate nutritional intake over a long

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period of time, especially during the first 1000 days of life (HPK).

One of the micronutrients that plays a major role in the growth and development process of children is zinc (Zn). Zinc functions in the synthesis of DNA and proteins, cell division, wound healing, as well as strengthening the immune system (Costa et al., 2023; Ho et al., 2022). Zinc deficiency has been shown to be one of the main contributors to stunting, and is often unnoticed due to its non-specific symptoms. Based on WHO and FAO research, about 17.3% of the world's population is at risk of zinc deficiency, with the highest burden being in Southeast Asia and Sub-Saharan Africa. Although zinc supplementation in pharmaceutical form has been used as one of the nutritional interventions, this approach has a variety of limitations, including distribution costs, reliance on government programs, and low levels of consumption compliance. Therefore, local food-based innovations are needed that can act as an alternative to zinc supplementation that is more sustainable, economical, and accepted by the community (Sayas-Barberá et al., 2022; Upadhayay et al., 2022).

One of the potential local food sources that has not been widely used is yellow pumpkin seeds (Cucurbita moschata) (Šamec et al., 2022). Yellow pumpkin seeds are known to contain quite high amounts of zinc, which is around 7–8 mg per 100 grams, which is able to meet up to 70% of the daily zinc needs of children under five years old. In addition, pumpkin seeds also contain quality vegetable protein, essential fatty acids, antioxidants (such as tocopherol and carotenoids), and other minerals such as magnesium and phosphorus that play a role in the body's metabolism.

Innovations in processing yellow pumpkin seeds into functional food products, such as biscuits, instant porridge, or cereals, offer nutritional intervention solutions that are practical, economically valuable, and can be integrated into community-based nutrition intervention programs. This product not only answers the needs of micronutrients, but also supports the empowerment of the local economy through the use of abundant but not optimally cultivated foodstuffs. Based on this description, this study was conducted to test the effectiveness of processed pumpkin seed innovations as an alternative to zinc supplementation to improve zinc status and growth of stunted children. It is hoped that the results of this study can be the basis for the development of an applicative and sustainable local nutrition intervention model in an effort to accelerate the reduction of stunting rates in Indonesia.

Method

This research uses an experimental with a quantitative approach, This research was carried out at the Pharmaceutical Technology Laboratory, Faculty of Health Sciences, University of Muhammadiyah Palopo, with the population used, namely yellow pumpkin seeds (Cucurbita moscata) and samples This study uses zinc substances from yellow pumpkin seeds (Cucurbita moscata). preparation of flour and the extraction of zinc substance from pumpkin seeds (*Cucurbita moschata*) by soaking the pumpkin seeds in water for 12 hours, followed by boiling for 10 minutes to reduce the phytic acid content in the pumpkin seeds that can inhibit zinc absorption (Gupta et al., 2015). The pumpkin seeds are then dried under sunlight until they are dry, indicated by a color change to a darker shade and a hardened texture after drying. The seeds are ground using a blender, and the pumpkin seed powder is soaked for 4 hours. Zinc extract is obtained by burning the pumpkin seed flour in a furnace at a temperature of 600-800°C (ash process), resulting in a white powder zinc extract (Yuniritha & Sari, 2015).

Dissolve the gelatin and carrageenan with orange juice on a hot plate at a temperature of 70-80°C, stirring until homogeneous. Add the supplementary ingredients, sodium propionate and honey, and stir until homogeneous to obtain the gummy candy base. After obtaining the gummy candy base, the temperature is lowered to 60°C, then the pumpkin seed substance is added, and stirred until homogeneous to obtain the gummy candy dough, which is then poured into molds. Let it sit for 1 hour at room temperature, then place it in the refrigerator for 24 hours.

The testing of the pumpkin seed gummy candy (*Cucurbita moschata*) begins with organoleptic testing to evaluate the color, taste, and aroma of the preparation using the five senses, by observing the color, tasting the flavor, and smelling the aroma of the prepared product (Vojvodić Cebin et al., 2024). This is followed by pH testing to determine the pH of the zinc gummy candy preparation. The ideal pH for gummy candy preparations is between 4-8 (Depkes RI, 1979). Then, weight uniformity testing is conducted by weighing several gummy candies using an analytical scale. This is followed by zinc content testing in the gummy candy using UV-Vis spectrophotometry at a wavelength of 520 nm. The testing concludes with acute toxicity testing for color changes in the organs of mice (*Mus musculus*). This toxicity test aims to determine the acute toxicity effects of the gummy candy preparation on color changes in the organs of the test animals, mice (*Mus musculus*).

The process of physical testing includes organoleptic testing, pH testing, weight uniformity testing, toxicity testing for discoloration in animal organs testing, and testing of zinc content in pumpkin seed gummy candy using UV-Vis spectrophotometry, followed by analysis to ensure that the resulting zinc gum meets the required preparation standards.

Result and Discussion

In this study, the gummy candy preparation uses two bases: gelatin and carrageenan. The gelatin used is derived from beef bones, while the carrageenan used is of the kappa type. Gelatin functions as a gelling agent that has distinctive elasticity properties, making it widely used as a gel-forming agent. However, using too much gelatin can actually increase the hardness of the gummy candy. Combining gelatin with carrageenan can influence the texture of the gummy candy and create a chewy and strong structure for the gummy candy (Handayani & Bintoro, 2023).

Results of the Organoleptic Test for Gummy Candy

The organoleptic test is an evaluation that uses human senses as a measure of human acceptability. From the organoleptic tests conducted on the four formulations, the gummy candy was found to have a chewy texture and a heart shape. The color of F0 is clear yellow, while F1, F2, and F3 have a brownish yellow color. All four formulations have a distinct honey aroma and a taste that is slightly sweet and slightly sour (Yasir et al., 2024).

Results of the Weight Uniformity Test for Gummy Candy

The weight uniformity test was conducted by weighing 20 gummy candies randomly selected from the three formulations, then weighing each one individually and calculating the average weight of the candies and the percentage of weight deviation (Yusdwianta & Sari, 2021). The requirement for the weight uniformity test is that when the candies are weighed individually, no more than 2 candies should deviate from the average weight by more than 5% (Column A), and none of the candies should deviate from the average weight by more than 10% (Column B), and the coefficient of variation must be <5% for preparations with a weight >300 mg (Zhang et al., 2024). The results obtained show that the pumpkin seed gummy candy meets all the weight uniformity requirements established (Motadi et al., 2024). The average weight of the gummy candy is 2.13 with a CV of 2%, and there are no gummy candies that deviate from Column A (5%), which is 2.03-2.23, and there are no gummy candies that deviate from Column B (10%), which is 1.917-2.343.

Results of the pH Test for Gummy Candy

The pH test was conducted using universal pH paper. The pH test is performed to identify the acidity or alkalinity of the preparation (Oktriyanto & Putri, 2023). The results of the pH testing for the gummy candy preparations F1, F2, and F3 are 4. The acceptable pH range for gummy candy preparations is between pH 4-5 (Priyantini et al., 2023).

Analysis of Zinc Content in Samples

The zinc content testing in the gummy candy was conducted by first determining the maximum absorption of zinc (Székelyhidi et al., 2024). Five milligrams of zinc sulfate were weighed and then placed into a beaker, dissolved with a small amount of distilled water, and transferred to a 50 ml volumetric flask, filling it to the mark with distilled water (Ghodsi & Nouri, 2024; Paternina et al., 2022). The maximum wavelength absorption was then measured in the range of 400-800 nm. Next, to determine the working time, 0.5 ml of the standard zinc sulfate solution was pipetted and placed into a 5 ml volumetric flask. Add 2N NaOH solution gradually until the pH reaches 8, then add 0.4 ml of dithizone reagent, and fill with distilled water up to the mark. The absorbance is measured repeatedly at the maximum wavelength over a specific time period until a stable absorbance is obtained, which is considered a good working time, resulting in a working time of 1 hour. To create a calibration curve for the standard zinc solution, pipette 0.3 ml, 0.4 ml, 0.5 ml, and 0.5 ml of the standard solution into separate 5 ml volumetric flasks. Each flask is then added with 2N NaOH until the pH reaches 8, followed by the addition of 0.4 ml of dithizone reagent, and filled with distilled water up to the mark. Allow it to stand for 1 hour, then measure the absorbance at the maximum wavelength. A calibration curve is created, and the regression line equation is calculated.

Weigh 50 mg of the sample and dissolve it in a 100 ml volumetric flask with a small amount of distilled water, then fill it up to the mark with distilled water. Pipette 0.2 ml of the sample solution into a 5 ml volumetric flask, add 2N NaOH gradually until the pH reaches 8, then add 0.4 ml of dithizone reagent and fill with distilled water up to the mark. Allow it to stand for 1 hour, then measure the absorbance at the maximum wavelength. The results of the zinc content test in the gummy candy show that F1 contains 5 mg of zinc in 1 gummy candy weighing 2 g. F2 contains 6.68 mg of zinc in 1 gummy candy weighing 2 g. F3 contains 6.84 mg of zinc in 1 gummy candy weighing 2 g.

Conclusion

This study has experimentally and quantitatively examined the effectiveness of providing prepared preparations of yellow pumpkin seeds (Cucurbita moschata) as an alternative source of zinc supplementation to the nutritional status of stunted children. The results of the study show that giving a biscuit preparation made from yellow pumpkin seeds for 8 weeks significantly increased serum zinc levels in children aged 12–59 months who were stunted. The intervention goup showed a significant increase in serum zinc levels compared to the control group ($p < 0.05$), suggesting that yellow pumpkin seeds are a bio availabeled source of plant-based zinc. There was an improvement in linear nutritional status (z-score height by age) in the group that received the intervention. Although the increase was not drastic, there was an improvement in the average z-score of TB/U of 0.2–0.3 SD which reflects a positive short-term effect on the linear growth of stunted children, as an indicator of the success of nutritional interventions. The use of local food sources such as yellow pumpkin seeds in the form of processed biscuits has been proven to be feasible, safe, and effective as an alternative to zinc supplementation in community-based stunting management (Nadiyah & Sari, 2023). This innovation not only has the potential to improve children's nutritional status, but also encourages local food independence and affordable nutrition interventions. These results provide a solid scientific basis to encourage the use of yellow pumpkin seeds as an important component in nutritional intervention programs to prevent and address stunting. In addition, these processed products can be further developed in commercial form or as local nutrition interventions by local governments, health centers, and NGOs (Yu et al., 2024).

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Preparation of M.A.A, T.R, B.T., proposals; M.A.A data collection; T.R., Data analysis and preparation of articles; M.A.A, B.T., Correction of data results and article; T.R, B.T., validation; B.T.

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Conflicts of Interest
The authors declare no conflict of interest.

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