Jurnal Mandiri IT
Vol. 13 No. 1, July (2024), pp. 63-71

ISSN 2301-8984 (Print), 2809-1884 (Online)
Published by Institute of Computer Science

Application of WASPAS method in determining the best flour for nastar making

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A R T I C L E I N F O

Article history:

Received May 31, 2024
Revised Jun 2, 2024
Accepted Jun 11, 2024

Keywords:

Food Industry;
Flour Quality;
Nastar;
Production Efficiency;
WASPAS.

ABSTRACT

This study explores the use of the Weighted Aggregated Sum Product Assessment (WASPAS) Method in selecting the best wheat flour for pineapple cake production. The aim of this study is to develop a more systematic and quantitative approach in assessing flour quality, provide useful guidance for pineapple cake producers and enrich the academic literature in the field of food science and food technology. This study used quantitative methodology data analysis and model validation with WASPAS, aimed at overcoming the challenge of selecting the best wheat flour for pineapple cake making. Results showed that the WASPAS method was effective in identifying the best flour, with Bungasari Hana Emas flour obtaining the highest WASPAS score of 0.952863, followed by the Falcon Hijau with a score of 0.931373. This score indicates the optimal balance between cost and quality. The study emphasizes the importance of objective decision-making tools in the food industry, suggesting that such an approach can significantly improve product quality and production efficiency.

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1. INTRODUCTION

Nastar cake is one of the most popular desserts, especially during certain celebrations such as Eid and Christmas as a symbol of togetherness and friendliness (Blum et al., 2023). The quality of pineapple cake is greatly influenced by the ingredients used, especially the type of wheat flour (Oladunjoye et al., 2021). Choosing the right flour can improve the texture, taste and appearance of pineapple cake (Ching et al., 2021). However, with various brands of flour available on the market, flour selection is a challenge for producers. Producers face various challenges in choosing the best wheat flour with many flour brands available on the market, the use of flour by producers must pay attention to the composition of the flour to ensure that the chosen flour gives the best results for nastar cakes. In addition, the cost of flour is also an important factor that must be considered to ensure production remains economical without sacrificing quality. This problem requires an objective method to determine the best flour that meets these criteria. The selection of the best wheat flour not only has an impact on the quality of the final product, but also on the efficiency of production costs(Ma et al., 2021). Errors in selection can result in a significant decrease in product quality or increase production costs without a proportional increase in quality (Ullah & Sarkar, 2020). This makes the selection of wheat flour an important issue and needs to be addressed with a systematic and objective approach (Cappelli et al., 2020).

This study was conducted to overcome this problem by proposing the use of the Weighted Aggregated Sum Product Assessment (WASPAS) Method as an objective solution in determining the best wheat flour for making pineapple cakes (Azbari et al., 2022). This method is proposed because it is able to provide more accurate results than other methods and can provide a more systematic and quantitative approach in assessing the quality of flour, based on criteria relevant to nastar cake making (Alimohammadlou & Khoshsepehr, 2022). The use of the WASPAS method can provide a framework for better decision-making in raw material selection, which is not only beneficial for nastar cake producers, but can also provide insights for research related to other foodstuffs (Alrasheedi et al., 2022). By overcoming this raw material selection problem, it is expected to improve the quality of food products and enrich academic literature in the field of food science and food technology (Scarano et al., 2022).

Previous research has shown the effectiveness of various approaches in multi-criteria decision-making in various industry sectors. The first article published in Expert Systems with Applications uses the q-ROF CRITIC-ARAS technique to select the most ideal critical business processes in the context of Lean Six Sigma in the food industry. This study shows that the approach is able to improve operational efficiency and effectiveness by identifying key success factors and applying them to real-world case studies (Aytekin et al., 2023). Furthermore, the second article also published in Expert Systems with Applications applies the Pythagorean fuzzy TOPSIS method for the selection of green suppliers in the food industry. The results of this study found that the method is effective in evaluating and selecting environmentally friendly suppliers based on various sustainability criteria, thus supporting sustainable practices in the industry (Hajiaghaei-Keshteli et al., 2023). In addition, a third article published in the Journal of Cleaner Production uses a multi-criteria decision-making approach to optimize the pineapple drying process. This study shows that the method is effective in balancing energy consumption, nutrient retention, and drying time, thereby improving product quality and reducing production costs (Chauhan et al., 2021). Further research published in Granular Computing combines Einstein's operator, the WASPAS method, and a neutrosophic set for multi-criteria decision-making. The results of this study show that the combination of these methods provides more accurate and reliable evaluations under complex conditions, so that it can be used as a valuable tool for decision-makers in various fields (Goyal & Rani, 2024). These studies highlight the importance of using multi-criteria decision-making techniques and methodologies in improving the efficiency, sustainability, and reliability of decision-making processes across various industries.

This study applies the Weighted Aggregated Sum Product Assessment (WASPAS) method, which was previously rarely applied in the context of food raw material selection, especially wheat flour. The innovation of this research lies in the adaptation and methodological validation of WASPAS in a context that has not been widely studied, with the aim of providing a more structured and objective framework for decision-making in the food industry. This adaptation involves adjusting parameters and evaluation criteria relevant to the quality of food raw materials, thus enabling empirical validation of the effectiveness of the method in a specific industrial setting. The purpose of this study is to develop a more systematic and quantitative approach in assessing flour quality, based on criteria relevant to nastar cake making, so as to provide useful guidance for pineapple cake producers and enrich academic literature in the field of food science and food technology.

2. RESEARCH METHOD

This study uses a quantitative approach that combines quantitative analysis and model validation using the Weighted Aggregated Sum Product Assessment (WASPAS) Method to overcome the challenge of selecting the best wheat flour in making nastar cakes. The following is a breakdown of the methodology used.

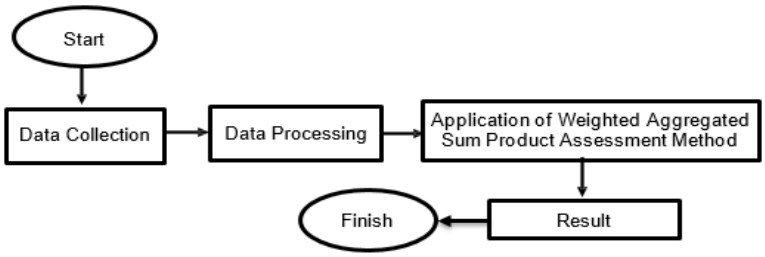

Figure 1. Research flow

In figure 1 the process starts with the data collection stage, where data are necessary for research. After the data is collected, the next stage is data processing which involves quantitative analysis to obtain accurate and reliable results. The core stage of this methodology is the application of the Weighted Aggregated Sum Product Assessment (WASPAS) Method, which is used to analyze data and determine the best choice based on predetermined criteria. The results of the application of the WASPAS method are then evaluated, providing conclusions from the research regarding the selection of the best wheat flour.

Data Collection

Data collection on price, protein, carbohydrate, iron, and zinc content was carried out through direct observation of the information listed on the packaging of each brand of wheat flour tested.

Table 1. Wheat flour data

Flour Brand	Flour Price	Protein	Carbohydrates	Iron	Zinc
Bogasari Kunci Biru	Rp13000	15%	24%	40%	40%
Bungasari Hana Emas	Rp14500	18%	23%	60%	55%
Falcon Hijau	Rp13000	19%	23%	45%	55%
Mila Serbaguna	Rp12500	17%	23%	25%	30%
Wilmar Sania	Rp13500	17%	24%	25%	30%

In table 1 presents a data set consisting of price, protein, carbohydrate, iron, and zinc content from five brands of wheat flour that have been collected from trusted online sources. This data consists of Bogasari Kunci Biru is sold at a price of Rp13000 and has a nutritional composition consisting of 15% protein, 24% carbohydrates, 40% iron, and 40% zinc. Meanwhile, Bungasari Hana Emas, which costs slightly higher, at Rp14500, has a protein content of 18%, carbohydrates 23%, iron 60%, and zinc 55%. Falcon Hijau, at the same price as Bogasari Kunci Biru, offers 19% protein, 23% carbohydrates, 45% iron, and 55% zinc. Mila Serbaguna is a more economical option at Rp12500, providing 17% protein, 23% carbohydrates, 25% iron, and 30% zinc. Finally, Wilmar Sania which costs Rp13500, has a nutritional composition similar to Mila Serbaguna, namely protein 17%, carbohydrates 24%, iron 25%, and zinc 30%. This data will be further processed through the normalization stage.

Data Pre-Processing

The data obtained will go through the pre-processing stage to ensure its quality by normalizing the data to facilitate the analysis process.

Table 2. Wheat flour data after normalization

Flour Brand	Flour Price	Protein	Carbohydrates	Iron	Zinc
Bogasari Kunci Biru	13000	0.15	0.24	0.4	0.4
Bungasari Hana Emas	14500	0.18	0.23	0.6	0.55
Falcon Hijau	13000	0.19	0.23	0.45	0.55
Mila Serbaguna	12500	0.17	0.23	0.25	0.3
Wilmar Sania	13500	0.17	0.24	0.25	0.3

Table 2 illustrates normalized data for the different brands of wheat flour involved in this study. This data normalization process is an important step in pre-processing to ensure that all variables such as price, protein, carbohydrates, iron, and zinc, are assessed on a consistent scale, making it easier to analyze and compare between products. In this table, brands like Bogasari Kunci Biru have protein normalized to 0.15 and iron 0.4, while Bungasari Hana Emas has protein 0.18 and iron higher at 0.6, signifying richer nutrient content. Falcon Hijau stands out with the highest protein at 0.19. Mila Serbaguna, although the cheapest, offers 0.17 protein, similar to Wilmar Sania, which also has the same proteins and carbohydrates. This normalization allowed the study to go further in applying the WASPAS method to objectively determine which of these brands offers the best balance between price and nutritional value, specifically for the manufacture of pineapple cakes (Patil & Majumdar, 2021).

Algorithm Implementation

The WASPAS algorithm implemented using processed data and optimized criteria weighting. This implementation done using statistical software or programming languages python.

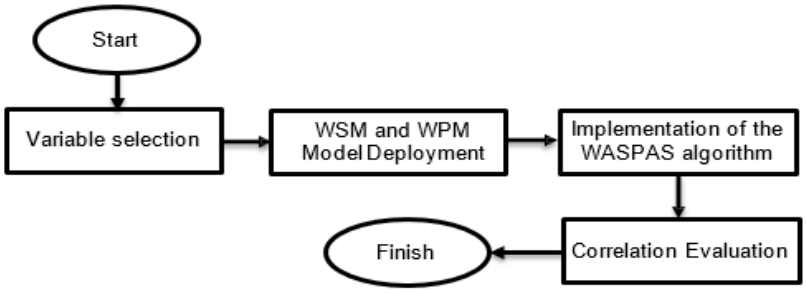

Figure 2. Algorithm implementation flow

In figure 2 the process starts with the selection of important variables such as price, protein, carbohydrates, iron, and zinc that have a significant influence on the final quality of the cake. Next, the Weighted Sum Model (WSM) and Weighted Product Model (WPM) models are applied to evaluate and synthesize the data of these variables, before integrating them in the WASPAS algorithm. The implementation of this algorithm is followed by a correlation evaluation to measure the extent of the relationship between the final WASPAS score and the ranking generated by the model. Evaluation of this correlation is important to ensure reliability and stability in calculations using the WASPAS method (Zhang et al., 2022).

WSM formula for calculating aggregate score by summing the product of normalized criteria values based on their weights (Ocampo et al., 2023).

$$WSM_i = \sum_{j=1}^{n} w_i \, . \, x_{ij} \quad (1)$$

Where, $WSMi$ is the value of the WSM calculation result for the alternative i. wj is weight for the criterion j. xij is a normalized criterion value. The total score of the WPM formula for each alternative is calculated by multiplying all normalized criteria and raising to the criteria weighted rank (Mokarrari & Torabi, 2021).

$$WPM_i = \mathrm{G}(x_{ij})^{wj}_{j=1}^{n} \quad (2)$$

Where, WPM_i is the value of the WPM calculation result for the alternative i. wj is the weight for the criterion j. xij is a normalized criterion value i. WSM and WPM integration in WASPAS Combining WSM and WPM scores to obtain a WASPAS score with lambda (λ) as a balancing parameter between WSM and WPM, it is common to take a value of 0.5 for the same distribution (Soni et al., 2023)

$$Q_i = \lambda \, . WSM_i + (1 - \lambda) \cdot WPM_i \tag{3}$$

Where, Qi is the WASPAS calculation value. This WASPAS score is then used to rank wheat flour.

Variable Selection and Model Optimization

Key variables (price, protein, carbohydrates, iron, and zinc) will be analyzed to determine their effect on pineapple cake quality. The selection of these criteria is very important because each contributes to the quality and cost of nastar cake production. This research applies WSM (Weighted Sum Model) and WPM (Weighted Product Model) methods, both of which are integrated into the WASPAS (Weighted Aggregated Sum Product Assessment) approach (Ali et al., 2021). This approach allows a balanced weighing between the total values summed and the resulting values of those variables, so that each variable can make a proportional contribution according to its weight (Chattopadhyay et al., 2020).

Algorithm Configuration and Model Evaluation

The configuration of the WASPAS algorithm will be carried out by assigning weights to each criterion, After determination of weights and normalization, evaluation of the model is carried out by applying WSM and WPM (Chetabi et al., 2023). Next, the evaluation of the results is continued with correlation testing which aims to measure the extent of the relationship between the final score of WASPAS and the ranking generated by the model (Eghbali-Zarch et al., 2022). This test is to ensure that the score generated by the model has a statistically significant correlation with flour ratings based on the calculation results of the WASPAS method. Thus, this process guarantees that the WASPAS model is not only theoretical, but also effective and relevant in supporting the decision of choosing optimal raw materials for the manufacture of pineapple cake.

Correlation analysis is a statistical technique used to measure and analyze the relationship between two variables (Xiang et al., 2021). Correlation indicates the extent to which two variables have a linear relationship that is whether an increase in one variable is related to an increase or decrease in another variable (Capblancq & Forester, 2021). Correlation has a formula on the equation (4)

$$r = \frac{n\sum_{i=1}^{n} X_i Y_i - \sum_{i=1}^{n} X_i \sum_{i=1}^{n} Y_i}{\sqrt{n\sum_{i=1}^{n} Xi^2 - (\sum_{i=1}^{n} X_i)^2}\sqrt{n\sum_{i=1}^{n} Yi^2 - (\sum_{i=1}^{n} Y_i)^2}} \tag{4}$$

Where, the letter n represents the number of dots of the variables X and Y, X represents the value of the variable X, Y represents the value of the variable Y

3. RESULTS AND DISCUSSIONS

The application of the Weighted Aggregated Sum Product Assessment (WASPAS) method in determining the best wheat flour for pineapple cake making provides significant insight, with an in-depth examination of key variables such as price, protein, carbohydrates, iron, and zinc. The optimized WASPAS model emphasizes the complex balance between cost efficiency and product quality.

During the study, the methodological alignment of WASPAS with WSM (Weighted Sum Model) and WPM (Weighted Product Model) facilitated a solid framework for flour brand evaluation. These results suggest that price and nutritional value are not mutually exclusive factors and that a

systematic approach can indeed determine the optimal product. The top-ranked wheat flour brand, Bungasari Hana Emas, demonstrates an exemplary balance between cost and quality parameters, making it a prime candidate for pineapple cake production.

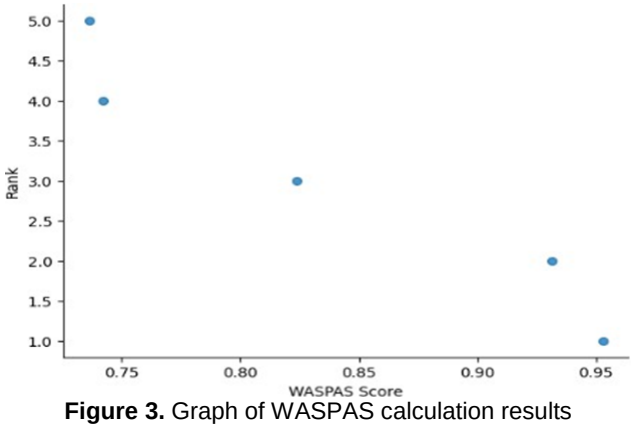

Figure 3. Graph of WASPAS calculation results

Based on Figure 3 this shows that out of 5 brands of wheat flour get a waspas score of 0.952863 for Bunga Sari Hana Emas which is ranked first. The green Falcon ranked second with a WASPAS score of 0.931373, then the blue key bogasari with a WASPAS score of 0.823899 ranks, then all-purpose mila flour with a WASPAS score of 0.742033 in fourth place and finally wilmar sania flour with a WASPAS score of 0.736320 in fifth place. WASPAS scores and ratings are obtained from the calculation of the WASPAS method using WSM and WPM models.

The results of the WASPAS calculation are then evaluated using correlation analysis to ensure reliability and stability in calculations using the WASPAS method. Correlation analysis is used to measure the extent to which the results obtained from the WASPAS method have a consistent linear relationship with the data. This correlation analysis ensures that the WASPAS method provides stable and reliable results for accurate and effective decision making.

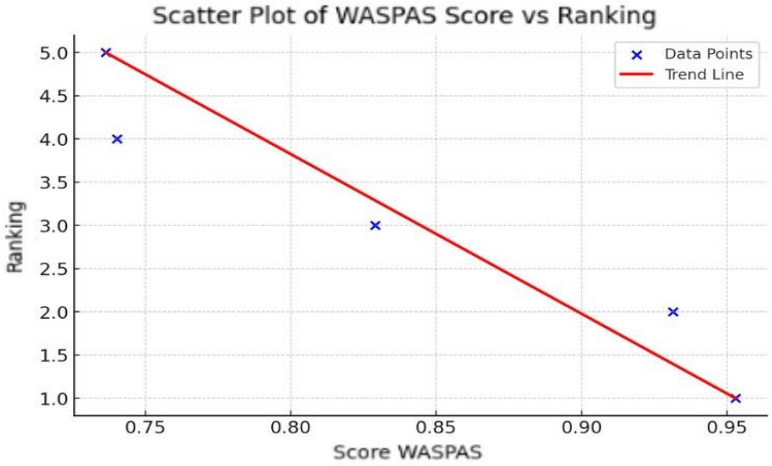

Figure 4. Graph of correlation analysis results

Based on figure 4 the results of correlation analysis show that the WASPAS method is very reliable and stable in providing consistent results. The strong negative relationship between WASPAS Score and Rating indicates that this method can be effectively used to rank wheat flour brands based on predefined criteria. A higher WASPAS score is always associated with better ratings, indicating that this method is reliable for accurate decision-making in wheat flour brand assessments.

The results of the pearson correlation evaluation show a value of -0.964371324968073 which shows a very strong negative correlation between the WASPAS Score and Ranking, meaning that the flour with the higher WASPAS score has a lower rating (rank 1 is the best), A correlation close to -1 indicates that the relationship between these two variables is almost perfect linearly, with a downward trend, In line with the expectation that a higher score indicates better quality. The spearman correlation result -0.9999999999999999 shows a perfect negative correlation which means the WASPAS score value and related rank monotonously. Any increase in WASPAS scores is always accompanied by a drop in rankings. This Spearman correlation close to -1 confirms that the data is perfectly sorted according to the WASPAS score in determining the ranking. The R-Squared result is 1.0 which means the R-squared value of 1.0 indicates that the linear regression model used has a perfect match. The correlation and R-squared value in this case show that the calculation and ranking methods used are very consistent and reliable. WASPAS scores are effective in predicting rankings, and regression models have perfect predictions of those scores based on the variables used. This corroborates the validity of the WASPAS method and its implementation in this analysis.

The results of this study compared to previous studies show that the WASPAS approach is able to fill the existing gap. For example, previous studies used the q-ROF CRITIC-ARAS technique in the context of Lean Six Sigma in the food industry to improve operational efficiency and effectiveness, while other studies applied the Pythagorean fuzzy TOPSIS method for the selection of green suppliers. Previous studies have also used a multi-criteria approach to optimize the pineapple drying process by considering energy consumption, nutrient retention, and drying time. Other research confirms the importance of using multi-criteria decision-making techniques in a variety of complex conditions by combining Einstein's operators, the WASPAS method, and neutrosophic sets.

This study not only confirms the effectiveness of the WASPAS method in a new context, but also expands the application of this methodology in the food industry, providing a more structured and objective framework for better decision-making in the selection of raw materials.

4. CONCLUSION

This study shows that the WASPAS method is effective in determining the best wheat flour for making nastar cakes, considering price, protein, carbohydrates, iron, and zinc. The Bunga Sari Hana Emas brand was voted the best flour, offering an optimal balance between quality and cost. Practically, this method helps producers select flour objectively, improve product quality, and production efficiency. Theoretically, this study introduces the use of WASPAS in the selection of food raw materials and provides insight into the quality factors of food products. Suggestions for further research are to develop this method for application to other foodstuffs and expand the evaluation criteria, including sensory aspects and consumer trials.

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to measure and analyze the relationship between two variables

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