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Enzymatically Improving the Quality of Gadung Chips (*Dioscorea hispida Dennst*) to Increase Selling Value

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Abstract

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Quality is the most important aspect that needs to be considered in a product. A quality product has a high economic value and increases consumer interest when purchasing the product. Gadung chips (*Dioscorea hispida Dennst*) are snacks made from gadung tubers by going through several stages such as peeling, slicing and frying. Gadung chips have a hard texture compared to other chips such as potato and cassava chips. Gadung chips are still ranked below cassava and potato chips in the consumption of many types of chips in Indonesia, this is because the quality produced in Gadung chips is still not widely accepted by the public. This is in line with data from the Central Bureau of Statistics which shows that the production capacity of cassava and potatoes is higher than that of gadung tubers. Efforts can be made to increase the selling value and texture quality of gadung chips by enzymatically modifying polysaccharides. Enzymatic polysaccharide modification aims to improve the quality of gadung chips so that it is expected to compete with other chips and be accepted by the wider community. The advantage of the enzymatic method is that it is safe and harmless to foodstuffs and has economic value, making it very effective to use. The purpose of this research is to increase the selling value of Gadung chips by enzymatically improving the quality so that it can compete with other chips. The results of this polysaccharide modification showed that the quality of crispness increased by 38% compared to without modification, the flavor increased by 30%, and the brightness of the product increased by 11%.

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Introduction

Chips are a type of snack that has the largest market share in Indonesia. Several types of chips that are widely consumed by Indonesians include gadung, potato and cassava chips. The production capacity of gadung tubers in Indonesia on productive land reaches 19 to 20 tons/ha (Anam and Arum 2017). Cassava productivity in Lampung Province ranges from 26.0-26.4 tonnes/ha. This value is lower than several regions in Indonesia such as Central Kalimantan, North Sumatra, West Sumatra, Riau and South Sumatra where cassava productivity is above 30 tons/ha. The potato harvest area in 2014 was 76,291 ha producing 1,347,815 tons with a productivity of 17.67 tons/ha. Meanwhile, the potato harvest area in 2015 was 66,983 ha producing 1,219,269 tons with a productivity of 18.20 tons/ha. Based on this data, potato productivity in Indonesia is still very low (Hidayah, 2017).

Gadung chips are a snack made from gadung tubers which go through many stages such as peeling, slicing, soaking, boiling, drying and frying (Sumantri *et al.*, 2020). Gadung chips offer good prospects for economic actors who want to produce a product with significant and promising profits. The current sources of competitive advantage are innovation and creativity (Safrizal, 2023). Employee performance is a stage of achievement as an employee's work achievement (Safrizal *et al.* 2020). Human resources are by far the most important asset for an organization (Safrizal *et al.* 2020). The era of globalization is always marked by rapid changes in overall economic conditions which cause a number of demands to emerge in response to the changes that occur (Safrizal *et al.* 2020). Focus on technologies that enable MCS to be implemented in smart cities, such as task management, data collection, incentive systems, monitoring, and cost-saving tools (Wildan *et al.*, 2023). High Quality of Service and client-based communication with AI-enabled services is determined by Quality of Experience (QoE), (Padmapriya *et al.*, 2023). Human Activity Recognition has been researched for the past few years (Victoria, *et al.*, 2022). Previous research found that CSR can increase company value (tarjo *et al.*, 2022). International trade is one of the efforts to increase economic growth and development (Priyadi *et al.*, 2022). As a financial institution that has an intermediary function, the role of banks is very important in the economic activities of a country, where banks become institutions that distribute funds and as a place for financial transactions, this makes banks unchanged like the pulse in the human body which is very much needed to support the smooth running of a country's economy (Ryandono *et al.*, 2022). Gadung chips are marketed in several areas such as Banyuwangi, Surabaya, Mojokerto, Batu and Malang (Anam and Arum, 2017). The quality standard for gadung chips is that they have a distinctive aroma and taste, clear white color, uniform size and crunchy texture (Zakiah *et al.*, 2019). The quality of gadung chips is influenced by the type of tuber used, the water content of the tuber that is good to use is low because it can produce chips that are crunchy and do not crumble easily when fried (Asgar, 2013). The quality requirements for gadung chips after frying according to Zakiah *et al.*, (2019) are as follows.

Table 1. Quality Requirements for Gadung Chips

No	Test Criteria	Unit	Quality Requirements
1	Condition:		
	a. Aroma	-	Normal/typical
	b. Flavor	-	Normal/typical
	c. Color	-	Normal
	d. Appearance	-	Normal
	e. Texture	-	Crispy
2	Wholeness	%	Minimum 80
3	Foreign object	-	There can't be any
4	Water	%	Maximum 6
5	Dye	%	There can't be any

6	Contamination :		
	a. Lead (Pb)	mg/kg	Maximum 2.0
	b. Copper (Cu)	mg/kg	Maximum 5.0
	c. Zinc (Zn)	mg/kg	Maximum 40.0
	d. Mercury (Hg)	mg/kg	Maximum 0.03
7	Cyanide (HCN)	mg/kg	Maximum 0.3

Source: Zakiyah *et al.*, (2019)

The weakness of gadung chips compared to other chips is their hard texture. This weakness makes the selling value of gadung chips lower compared to potato and cassava chips. Apart from making the selling value low, this can also result in the market share of gadung chips not being maximized in Indonesia. The average market price for gadung chips is IDR 50,000/kg, potato chips IDR 90,000/kg and cassava chips IDR 65,000/kg (Supristiwendi *et al.*, 2018). Based on sales results on the market, Gadung chips have a low selling value compared to other chips. Efforts that can be made to increase the selling value of gadung chips are by improving the quality. Improving the quality of gadung chips, especially those with a hard texture, can be done through enzymatic modification of polysaccharides to increase crunchiness. Enzymatic is the modification of compounds with the help of enzymes in their work, where modification of gadung chips polysaccharides can use the enzymes amylase and pectinase (Fauziyah, 2012).

RESEARCH METHODS

This research uses descriptive and quantitative methods. Quantitative descriptive research is research that explains, describes, examines and draws conclusions about an observed phenomenon using numbers (Sulistyawati *et al.*, 2022) . This research The aim is to analyze the quality of Gadung chips which is economically good compared to other chips so that Gadung chips can compete with other chips on the market. This research uses research and development (R&D) research, where this type of research focuses on developing gadung chips products that already exist on the market by modifying them enzymatically (Okpatrioka, 2023). Enzymatic modification is a modification process that requires the help of enzymes, where the addition of enzymes to gadung chips aims to increase the crispness of the gadung chips produced so that they have a high selling value. The experimental design used in this research was factorial RAL (Completely Randomized Design). The factors used in the research are the type of enzyme and concentration, where the types of enzymes used are amylase and pectinase enzymes, while the concentrations used are 1 gram, 2 grams and 3 grams. The experimental design in this research can be seen in the table below.

Table 2. Experimental Design

Treatment	Deuteronomy I	Deuteronomy II	Deuteronomy III
J1K1	J1K1 I	J1K1 II	J1K1 III
J1K2	J1K2 I	J1K2 II	J1K2 III
J1K3	J1K3 I	J1K3 II	J1K3 III
J2K1	J2K1 I	J2K1 II	J2K1 III
J2K2	J2K2 I	J2K2 II	J2K2 III
J2K3	J2K3 I	J2K3 II	J2K3 III

Information :

- J1K1 = Amylase enzyme 1 gram
- J1K2 = Amylase enzyme 2 grams
- J1K3 = Amylase enzyme 3 grams
- J2K1 = Pectinase enzyme 1 gram

J2K2 = Pectinase enzyme 2 grams

J2K3 = Pectinase enzyme 3 grams

Tools and materials

The tools used in this research include knives, basins, choppers, plates, stoves, pans, food tongs, deep fryers, ovens/cabinet dryers, texture analyzers, moisture analyzers, saucers, watch glasses, spatulas, desiccators, beaker glasses, thermometer, stopwatch, analytical balance, baking sheet, spoon, drainer. The materials used include gadung tubers, rubbing ash, amylase enzyme, pectinase enzyme, cooking oil, kitchen tissue, jars, gloves, aluminum foil and standing pouch/plastic clip. The gadung chips production process goes through several stages including peeling, washing, slicing, detoxification, washing, soaking in water and enzymes, *bleaching*, drying, *deep frying*, slicing, packaging, texture testing, taste testing and color testing.

Peeling, Washing and Slicing

The process of peeling the skin of gadung tubers is done manually by hand with the help of a knife and gloves. Gadung tubers that have been peeled are then washed using running water until clean. Gadung that has been washed until clean can be chopped or sliced. The process of slicing gadung tubers is carried out using a manual tool in the form of a wooden chopper equipped with a sharp knife.

Detoxification

The detoxification process is a process of removing toxins (Ramayulis, 2014). Detoxifying gadung tubers is by sprinkling gadung that has been chopped or sliced with rubbing ash placed on a baking sheet. Gadung that has been detoxified with rubbing ash is then subjected to a drying process to maximize the process of removing toxins from gadung tubers. The drying process is carried out using an oven or cabinet dryer, where the gadung is placed on a baking sheet in a row. The temperature used in drying is 50°C for 6 hours.

Washing, Water Soaking and Enzymes

Washing aims to remove and clean dirt and foreign objects as well as the cyanide content in gadung (Mustafa, 2015). The washing process is carried out until the scoured ash on the gadung is clean, then soaked in water for 3 days at room temperature. The process of soaking the gadung in water for 3 days also includes rinsing 3 times. Enzyme soaking aims to increase the crunchiness of the gadung chips produced. The process of soaking gadung chips is carried out for 12 hours, where the enzyme is dissolved in 1 liter of water.

Bleaching and Frying

Bleaching is a heating process carried out to inactivate enzymes that can change the color, texture and taste of a food (Mariani and Ghazali, 2019). The bleaching process in making gadung chips is by boiling with boiling water. The technique used is boiling for 10 minutes at a temperature of 90°C. Process Drying of Gadung chips was carried out using an oven at 40°C for 4 hours.

Deep Frying, Slicing and Packing

Deep frying is a frying technique that involves immersing food in hot and large amounts of oil. The purpose of frying using the deep frying method is to produce food ingredients that are cooked evenly and uniformly from the surface to

the inside of the food (Praseptiangga et al., 2020). The process of frying gadung chips using a deep fryer takes 2 minutes at a temperature of 180°C. The process of draining the gadung chips is carried out for 2 minutes on kitchen tissue until the oil content decreases and the temperature of the chips decreases. Gadung chips that have cooled and the oil has dropped can be packaged to prevent changes in the texture of the chips. The packaging used for Gadung chips in this research was a standing pouch or plastic PP clip as the primary packaging, while the secondary packaging was in the form of a container with strong adhesive which is usually called a jar. The resulting product is then tested for texture, taste and color to determine the best results from gadung chips for each treatment.

RESULT

Economic feasibility analysis

Economic feasibility analysis is one of the efforts made to determine the costs involved in and out of building a project to determine the profits and losses of a company (Sakinah et al., 2021). Economic analysis of gadung chips production in a company is very important to know the costs incurred during the production process. The following is a breakdown of the costs of producing gadung chips for one of the business groups in Semarang Regency (Chrismianto et al., 2018).

Table 3. Calculation of Increase in Sales Value of Gadung Chips

No	Items	Total Cost (IDR)
1	Gadung tubers 85 grams x Rp. 14	1,190
2	Production Costs (labor + profit + overhead)	1,810
3	for 1 ounce/100 grams of $\frac{1}{2}$ finished Gadung chips	3,000
4	85 grams of Gadung chips $\frac{1}{2} = 85 \times \text{IDR } 30$	2,550
5	Production costs (cooking oil, seasonings, packaging)	2,950
6	85 grams $\frac{1}{2}$ finished	
7	Added value to chips entrepreneurs	1,500
8	Selling price/100 grams (1 pack) entrepreneur	7,000
9	Packaging	1,000
10	Distribution Services for packaged Gadung chips products	2,000
	Gift shop profits	3,000
	Gift shop selling prices	13,000

Source: Chrismianto et al., (2018)

Based on the table above, it shows that the calculation of the economic value of gadung chips which aims to improve quality and added value gets a net profit of IDR 1,500/pack. One pack of packaging has a net weight of 100 grams, so the net profit of Gadung chips entrepreneurs reaches IDR 15,000/kg. The profits of gadung chips entrepreneurs increased by 21%, where the increase in gadung chips can be calculated using the following formula.

$$\begin{aligned}
 \text{Profit} &= \frac{\text{added value to chips entrepreneurs}}{\text{selling price}} \\
 &= \frac{\text{Rp } 1.500}{\text{Rp } 7.000} \times 100\% \\
 &= 21\%
 \end{aligned}$$

Table 4. Differences in Chip Profit Levels

Types of Chips	Selling price	Profit Percentage
Gadung	IDR 50,000/kg	21% (Chrismianto et al., 2018)
Cassava	IDR 65,000/kg	40% (Sulaiman et al., 2018)

Potato

IDR 90,000/kg

84% (Jafaruddin, 2021)

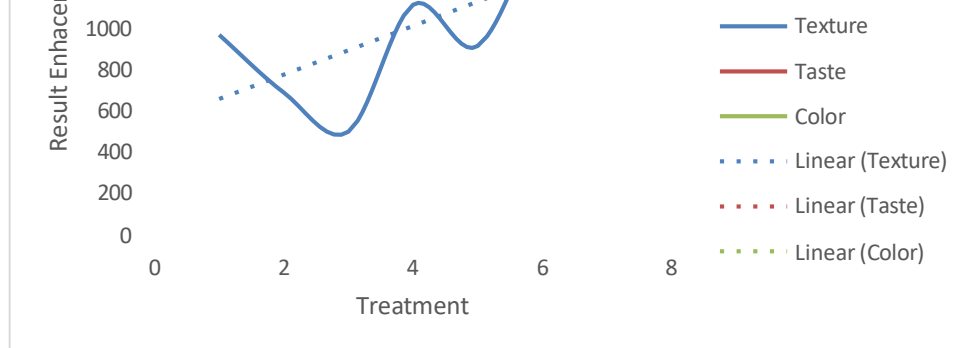
Based on the table above, it shows that the selling price of Gadung chips per kilogram is IDR 50,000 with a profit level of 21% (Chrismianto *et al.*, 2018). The selling price of cassava chips per kilogram is IDR 65,000 with a profit level of 40% (Sulaiman *et al.*, 2018). Potato chips have the highest selling price among gadung and cassava chips, namely IDR 90,000 per kilogram with a profit rate of 84% (Jafaruddin, 2021). This shows that the economic value of gadung chips is lower than cassava and potato chips. The economic value of Gadung chips is still low due to several factors such as the quality of texture, taste and color which is still less good than other chips (Agustina and Hanifuddin, 2021).

Texture is one of the most important parameters of chips. The crispness of the chips can be checked with a *texture analyzer*, where the mechanism of this tool is to use the help of *texture expert software* which produces graphs and data in the form of numbers (Lastriyanto *et al.*, 2019). Taste parameters are one of the important parameters in chips, where taste greatly influences whether a product is accepted or not by consumers. Taste parameters can be measured through organoleptic testing using the hedonic method, where this test is carried out by several respondents who try and rate the product based on the highest to lowest value according to the respondent's preferences (Irmayanti *et al.*, 2018). Apart from taste and texture, one important parameter is the appearance of the product. Consumers' decisions in buying a product are based on its appearance. One of the physical appearances that consumers see is color. Gadung chips color testing was carried out using a color reader, where the standard for gadung chips is to have a white, slightly yellow color so that the results of the *L or brightness parameter are very influential on this research. The higher the *L value, the brighter and better the gadung chips, and vice versa, the lower the *L value, the darker the product (Nalurita *et al.*, 2023). The following are the results of testing for texture, taste and color which can be seen in the table below.

Table 5. Texture, Taste and Color Test Results

Treatment	Texture (crispness) (g)	Taste (hedonic)	Color *L
J1K1	971.43	3.00	46.4
J1K2	691.33	3.18	37.8
J1K3	501.33	3.18	42.6
J2K1	1117.26	3.64	51.2
J2K2	917.34	3.91	56.0
J2K3	1539.34	3.73	47.7

		1539.34	
	1117.26		
971.43		917.34	
691.33			
	501.33		
		56.0	
46.4	3.718	43.2168	51.64
		3.91	3.773



Picture 1. Gadung Chips Quality Improvement Graph

Based on the table and graph above, the results of testing the quality of Gadung chips show that the best treatment for the texture of Gadung chips is J2K3 or Gadung chips with the addition of pectinase enzyme with a concentration of 3 grams which produces a crispiness level of 1539.34 grams. The treatment that produces the best taste is J2K2 or gadung chips with 2 grams of pectinase enzyme which produces a score of 3.91 based on a questionnaire that has been assessed by respondents. The results of testing the color of Gadung chips with the best treatment using a *color reader* were the J2K2 sample or 2 gram pectinase enzyme, where the resulting value was higher than the other samples, reaching 56.0. Based on the data analysis, it can be concluded that Gadung chips with the addition of the amylase enzyme produce poor grades, while chips with the addition of the pectinase enzyme produce good grades so that the best treatment is to use the pectinase enzyme with a concentration of 2 and 3 grams. According to Ariani (2016), the mechanism by which the amylase enzyme works is to break down the starch in chips into smaller sugar molecules so that when the chips are fried, *browning* or browning occurs (Ariandi, 2016). The mechanism of the pectinase enzyme is to catalyze the hydrolysis reaction of pectin compounds and produce galacturonic acid (Putri *et al.*, 2013).

Table 6. Percentage of Quality Levels of Gadung Chips

Test Criteria	Parameters (%)
Texture	38
Flavor	30
Color	11



Picture 2. Gadung Pectinase Enzyme Chips



Picture 3. Gadung Amylase Enzyme Chips

The quality level of Gadung chips is very important and needs to be considered to increase the selling value of the product so that it can compete with other chips (Raharjo and Mulyanto, 2018). Based on the results of texture, taste and color testing, the process of adding enzymes to Gadung chips experienced various improvements. Based on the results of texture testing in the treatment of amylase and pectinase enzymes with different concentrations, it increased by 38%. The taste test results for gadung chips with the addition of amylase and pectinase enzymes with different concentrations increased by 30%, while the brightness color test criteria for gadung chips increased by 11%. This shows that the parameter that is very influential and increases significantly is texture, so this research is expected to improve the texture quality of hard gadung chips on the market. The modification of gadung chips polysaccharides with enzymes could be an opportunity for entrepreneurs to shift the market for potato and cassava chips which is quite fast in Indonesia.

CONCLUSION

Based on the research that has been carried out, it can be concluded that gadung chips still have a low selling value compared to potato and cassava chips. Therefore, to increase the selling value and compete with other chips, the quality of Gadung chips is improved through enzymatic modification with the help of amylase and pectinase enzymes. The results of the research showed that the best treatment for gadung chips was the addition of pectinase enzyme with a concentration of 2 grams and 3 grams. The improvement in the texture quality of gadung chips was 38%, taste 30% and color or brightness 11%.

GRATEFULNESS

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