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The influence of food dimension (texture and volume) from processed rice (steamed-rice, lontong and ketupat) to the perception of satiety and consumer satisfaction level

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KEYWORDS

Ketupat
Lontong
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Satisfaction Level
Visual Analogue Scale

ABSTRACT

It has been commonly perceived for majority Indonesian public that unless eating steamed-rice, they would not be feeling full. This current study aims to investigate possible reasons in sensory perspective to understand that public perception on satiety of Indonesian traditionally rice products, including steamed rice, 'lontong' and 'ketupat'. Samples were presented by both same amount of mass (iso-mass) and same amount of calorie (iso-calorie), which allows modifying satiety perceptions. The assessment was conducted by measuring modified Visual Analogue Scale (VAS). Based on Pearson Correlation method, the result indicates that satiety perception tends to be affected by dimensions (volume of rice products) in both iso-mass and iso-calorie servings ($\alpha<0.05$). However, the level of satisfaction did not showed a strong correlation to any physical parameters of samples. Therefore, it is suggested that psychological driven factor such as food habit is more dominating in terms of rice satiety in Indonesia rather than metabolic factor.

Introduction

Rice farming productivity in Indonesia has increased during the period 2000 – 2013 (Bantacut, 2014). This productivity contributed to the national rice supply, in which most Indonesians depend on rice as an important staple food (Izumi et al., 2011). As staple food, rice is not only being served as steamed-rice but also other rice products that traditionally proceed in Indonesia. Those include lontong and ketupat which are produced basically by gelatinization. Lontong is usually cylindrical rice wrapped in banana leaf (Suwardiah and Lukitasari, 2017). Ketupat is a rice-based food wrapped in woven young coconut leaves or "janur" in the Javanese language (Rianti et al., 2018). Interestingly, three processed rice tend to get different public judgments related to satiety after consuming them, in which people tend to unsatisfied and feel hungry unless they eat steamed-rice. Therefore, a sensory study on the perception of satiety and the level of satisfaction on three processed rice is required.

The perception of satiety in general can be influenced by the portion of food and energy (calories) resulting from the burning of food. The portion of food that refers to the amount and volume of food, can affect the physical satiation associated with the fulfillment of the digestive tract (Banelam, 2009). Several factors that may affect selection of portions are classified into 3 categories by English et al. (2015) food environment (e.g. size and social influence), food characteristics (shape, palatability and energy density) and individual characteristics (hobbies of eating, weight and age). The calorie in foods affects the metabolic satiety. Foods that contain high calories will increase energy intake while low-calorie foods will reduce energy intake (Martin et al., 2007). Both of these factors actually work synergistically in affecting the satiety after consuming the food.

In the present study, the difference in satiety of perceptions is related to the different dimensions of food possessed by the three rice preparations including texture, volume, and color. Experiments are divided into two treatments for conditioning iso-mass and iso-calorie.

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Research Methods

Panelists

The study involved 80 male panelists (n = 25) and women (n = 55) with an age range of 19-23 years. The number of panelists required in this study refers to the research of Flint et al. (2000) who suggest that to get valid results and minimize any error data, then on the use of Visual Analogue Scale (VAS) required at least 70 panelists. Panelists were conducting tests at the Sensory Analysis Laboratory, Faculty of Agricultural Technology, Universitas Brawijaya, between 08.00 am and 12.00 pm. The panelists were required to fast for at least 4 hours.

Materials

Equipment used in sensory testing are digital scales, Denpoo rice cookers, knives, cutting boards, spoons and paper plates. For textural analysis, tensile strength "Imada ZP-200 N" was used. Meanwhile, calorie analysis was conducted by bomb calorimeter "DDS CAL2K".

Sample

In the experiment 1 sample of rice, lontong and ketupat were cooked using IR 64 super rice, then presented based on the equal weight of 80 g (iso-mass). Meanwhile in rice products were served based on the equal calories of 250 kcal (iso-calorie) the experiment 2. Commercial mineral water was also provided as palate cleanser.

Instrument

The main instrument is a questionnaire sheet to be filled by the panelist to record their satiety and satisfaction. The questionnaire sheet consists of two parts: the introduction (personal data) and assessment section. The introductory section was printed on one sheet for each panelist containing the panelist identity (name, age, gender, height and weight), execution time, panelist participation statement, and general instructions. The scoring section was printed on six sheets (two for each sample) to be filled by the panelists to determine satiety and satisfaction the form of modified VAS.

Methods

The study was designed as Nested Design in which both iso-mass and iso-calorie treatment were observed. Physical parameter analysis includes measurement of dimension and volume of each rice products. The data obtained was processed using statistical software Minitab 16.2 with general linear model (GLM). Pearson correlation was conducted to correlate physical parameters (texture and volume) and the level of satiety as well as satisfaction.

Calorie Analysis Procedure

The calorimeter bomb tool is used for caloric analysis of the sample. The three tested samples, weighed with a mass of 0.5 g, were then inserted in a dish in a calorimeter bomb unit in the form of a vessel. Then the combustion tube filled the oxygen cylinder and the air pressure is set between 2500-3000 bar. The calorimeter lid is closed and the combustion process takes approximately 10 minutes and the resulting combustion calorific value will appear on the calorimeter bomb display (Flint et al., 2000). The repetition for each type of sample is performed 5 (five) times.

Textural Analysis Procedure

Texture analysis begins with sample preparation of rice, lontong and ketupat. Each lontong and ketupat are cut with the same height or thickness. Then the tensile strength device, the computer is turned on and connected using software for tensile strength. The sample to be measured is placed under the suppressor accessories that have been adapted to the type of sample used. Then the button is pressed for testing and automatically the computer notes the force (N) (Anuar et al., 2016). Measurements for each type of sample were repeated a number of 5 (five) times with different samples**.**

Results and Discussion

Food dimensions may affect food quality such as color, shape, portion (volume), texture, and taste (Anuar et al., 2016). The following is the physical sample parameters data can be seen in Table 1.

Table 1. Volume and texture of rice products in both iso-mass and iso-calorie treatment

Sample	Iso-mass		Iso-calorie	
	Volume (cm^3)	Texture (kg/cm^2)	Volume (cm^3)	Texture (kg/cm^2)
Steamed-rice	94.23 ± 5.52^a	4.59 ± 0.67^b	86.11 ± 4.39^a	4.60 ± 1.14^b
Lontong	61.78 ± 4.11^b	5.07 ± 0.44^b	66.64 ± 3.74^b	4.81 ± 0.92^b
Ketupat	21.19 ± 1.55^c	7.76 ± 0.60^a	31.77 ± 1.47^c	6.84 ± 0.99^a

Different superscripts at the same column indicate significant differences.

Based on Table 1 data, steamed-rice has a larger volume than the other samples. This is because rice directly in contact with water, so as to speed up the reaction between water, starch granules in the presence of heat (Wang et al., 2010). The dimensional similarity between lontong and ketupat lies in the compactness of the product structure, meanwhile steamed- rice tends to be grainy and less compact. The compactness of lontong and ketupat may be attributed by the pressure inside the wrapper as during gelatinization, there would be the limited expansion space between the rice grains (Nawiyanto et al., 2011).

In addition, the volume of rice is influenced by direct contact between rice and water. The more water contact with the rice will affect hardness, volume, and stickiness (Sriwas and Jindal, 2007). Ketupat has the lowest volume compared to the other two samples due to its high structural compactness. Moreover the coconut leaves have smaller pores compared to banana leaves, thus the contact between rice and water is limited. The structure of the ketupat is positively correlated with the structural parameters, where it appears that the average ketupat has a compacted texture. It was also similarly suggested that ketupat has a compact texture, smooth and sticky with a moderate amylose content (Rianti et al., 2018). Those are attributed by the use of coconut leaves as the wrappers.

Initial Satiety Level

Initial satiety levels are preliminary before testing or before meals. The level of satiety is closely related to the level of hunger. According to Flint et al. (2000), hunger is a factor or builds a sense of control for eating. Hunger is a physiological response when the stomach is empty. This is influenced by the work of the body's systems, namely the physiological peripherals and metabolic processes that will be linked to the work of the brain (Sudha et al., 2013). Assessment of initial satiety level is needed to determine the satiety index or the value of adding satiety after consuming the sample later. In addition, this assessment is also needed to determine the value of perceived satisfaction of each panel after treatment (Naslund and Hellstrom, 2013). Based on General Linear Model (GLM) analysis in Table 2 shows that the average value of initial satiety of panelist perception did not differ greatly in the test of each sample. The initial condition was assumed equally by asking the panelists not to take any food or drinks but water for 4 hours before evaluation.

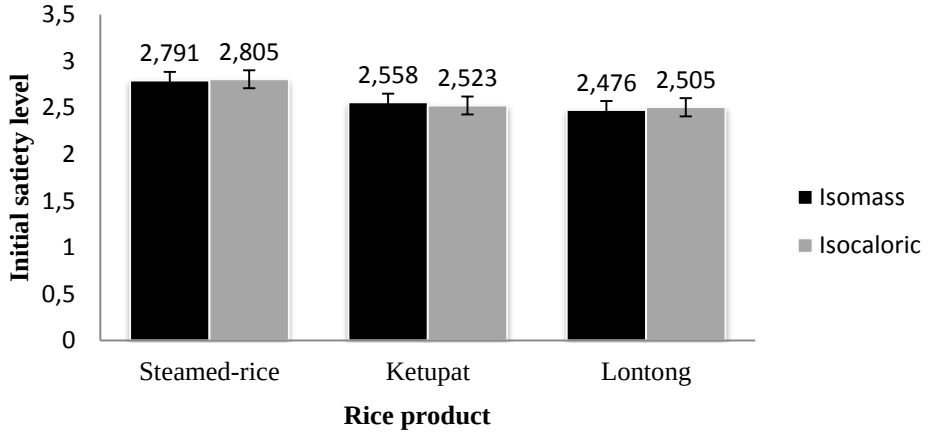

Figure 1. Initial satiety level three different rice products

Final Satiety Level

As shown in Fig. 2, final satiety provided by iso-caloric treatments are significantly lower than those by iso-mass treatments (p-value<0.05). Rice provides the highest satiety value compared to lontong and ketupat. Thus, it may suggest that not only metabolic factors which are affecting the response, but also sensory and psychological factors may be contributing to final satiety level. Furthermore, it may related to the different dimensions of the food. Steamed-rice was cooked without a wrapper to allow the starch in the rice to undergo gelatinization process optimally. Each grain will expand without pressure between the grains so that the volume of food owned rice becomes larger (Chambers et al., 2014). The volume of food is also directly proportional to the surface area of the rice. Therefore, the possibility of rice comes into contact with the wall of the gastrointestinal tract may be larger (Larasati,

2012). Thus, the digestive tract will be full and consequently will affect satiety level.

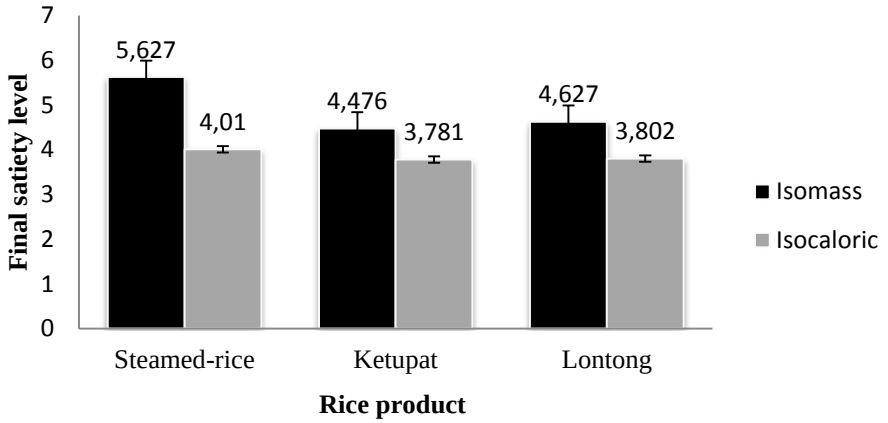

Figure 2. Final satiety level of three different rice products

Satiety Index

According to Flint et al. (2000), the level of initial satiety or a person's hunger affects appetite and a person's level of satiety. This shows that the initial glut rate can affect the addition of satiety. In addition, the different types of testing scales can affect the response of panelists to the addition of glut parameters. In iso-mass and iso-calorie tests, steamed-rice provides the highest satiety improvement (p-value<0.05), in which iso-caloric treatments is consistently lower than that of iso-mass treatment. Similar trend was also observed final satiety level as previously discussed. It was suggested that physical characteristics of food dimensions and volume are the dominant factors affecting the satiety index (Brustrom et al., 2010).

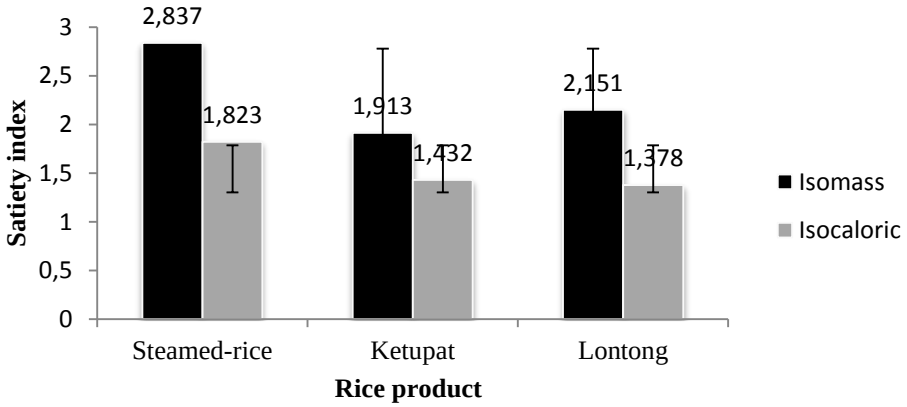

Figure 3. Satiety index of three different rice products

Based on Fig. 3, it can be seen that there are differences in perceptions of the final satiety level. Rice has the highest iso-mass and iso-calorie scores of 2.837 and 1.823 compared to other samples. Rice has the highest iso-mass and iso-calorie scores of 2.837 and 1.823 compared to other samples. While for the iso-calorie, the p-value is 0.000 ($p < 0.05$). This shows that iso-mass and iso-calorie give a real difference to the three samples based on the perception of adding satiety.

Level of Satisfaction

Differences in types of processed rice have no significant effect on the level of satisfaction as indicated by Fig. 4. The level of panelist satisfaction is not directly proportional to the level of satiety, which is indicated by the results of different interpretations of different p-values. This shows that there are other factors that influence the level of panelist satisfaction in addition to metabolic factors. According to Kotler (2002), the level of satisfaction is one of the psychological properties of humans where there is a feeling of pleasure or disappointment as a result of comparisons between perceived or expected products. The psychological factor of panelists in this case tends to have more influential on satisfaction response.

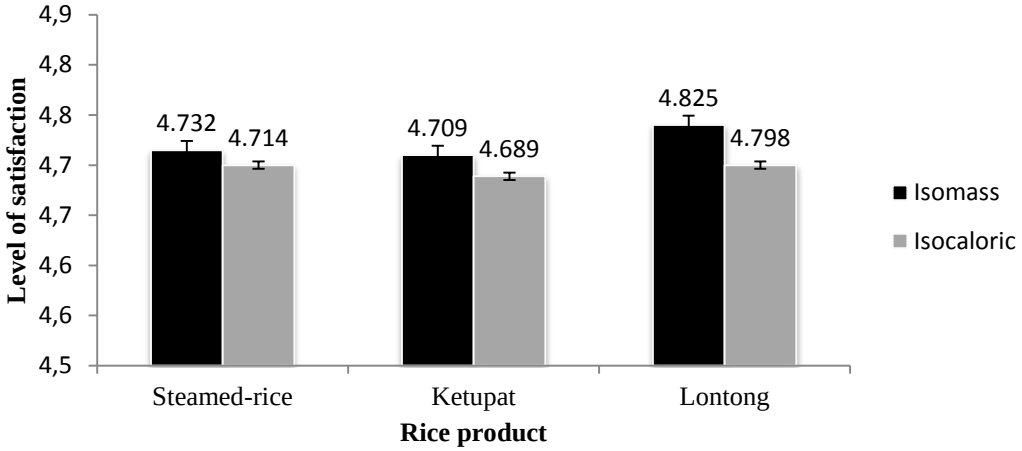

Figure 4. Satisfaction level on three different rice products

Correlation of Physical Parameters to Consumer Response

The results showed that the volume and texture are correlated to satiety and satisfaction levels for iso-mass testing. While on iso-calorie test only volume parameters are correlated to the level of satiety and satisfaction. According to Rolls et al. (1999), weight gain or volume will change the nutrient dispersion consumed and affect the mechanism of satiety formation. In addition, the amount of water contained in the food can affect the increase in satiety. This is supported in the Osterholt et al. (2007) study in which volumes can provide visual stimuli that may affect panelist perceptions in assessing satiety.

Table 3. Data from Pearson Correlation Analysis

Response	Physical Parameters	Iso-mass		Iso-calorie	
		p-value	r	p-value	r
The level of satiety	Volume	0.000*	0.381	0.000*	0.162
	Texture	0.000*	0.259	0.060	0.024
Level of satisfaction	Volume	0.000*	0.293	0.028*	0.058
	Texture	0.019*	0.605	0.490	0.010

*p-value < 0.05 indicates a correlation

Pearson critical value for 80 panelist is 0.2319

Correlation of the level of satiety and satisfaction of panelist personal data

Based on the Table 4 showing the real difference ($p < 0.05$), on the relationship of perceptions of final satiety to the gender of panelists with a p-value of 0.025. In general, the final glut of panelist perceptions with male sex is likely to be lower, compared with female panelists. According to Vendhoth (2008), men tend to require more energy due to physical activity, and higher cell metabolism than women, so that the perception of satiety of restrained will be longer than women. This causes women tend to have a higher intensity of satiety.

Table 4. Correlation of satiety and satisfaction with panelists' personal data

Relationship with panelist's personal data	Category	p-value
Initial Satiety Level	Gender	0.723
	Age	0.519
	Weight	0.178
Final Satiety Level	Gender	0.025*
	Age	0.610
	Weight	0.121
Adding Satiety	Gender	0.056
	Age	0.678
	Weight	0.081
Level of Satisfaction	Gender	0.478
	Age	0.140
	Weight	0.234

*p-value < 0.05 indicates a significant influence

Conclusions

The initial satiety and satisfaction levels showed significantly different results ($p < 0.05$), while for the final satiety and added satiety, the results were significantly different ($p < 0.05$). This suggests that the level of satisfaction is not positively correlated with the final satiety, which can be interpreted after consuming satiety foods is not necessarily followed by a comparable satisfaction. In iso-mass testing, the volume and texture of the samples showed a strong correlation ($p < 0.05$) with the final satiety and satisfaction levels. Iso-mass affects the volume and texture of the material to the level of satiety and the level of satisfaction, whereas the iso-calorie are only influenced by the volume of the material. This suggest that within the scope of rice samples, dimensional attributes such as volume are more likely to affect the level of satiety and level of satisfaction.

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Conflict of interest

The authors declare that there is no conflict of interest in this publication.

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