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Designing Coconut Biscuit Packaging Using the Kansei Engineering Method

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ABSTRACT*: Coconut biscuits are one of the snacks favoured by the Indonesian people. The current coconut biscuits packaging has several shortcomings, namely that the opened biscuits cannot be resealed because they do not have a cover, so bacteria easily contaminate the contents of the product, require additional containers to store the product so that it is difficult to store, the packaging material only uses plastic which causes the product to be easily destroyed, and the product is quickly scattered when the packaging is opened. Therefore, this study aims to determine the design concept for coconut biscuit packaging that aligns with consumer priorities. The coconut biscuit packaging design concept was planned using the Kansei Engineering method with the Principal Component Analysis (PCA) supporting method. The Kansei words obtained were 47 words. The results of the packaging concept obtained were one Principal Component (PC) with the most significant standard deviation on PC 1 with a value of 7.5565, so it can be concluded that the optimal packaging concept is ergonomic and complex.*

Keywords: *Coconut Biscuits; Kansei Engineering; Packaging; PCA; Planning*

1. INTRODUCTION

Biscuits are popular due to their rich flavor and satisfying crunch, making them a favored snack choice. According to the Agricultural Data and Information System Center (2015), the demand for dry cakes, especially biscuits, in Indonesia is very high, reaching 24.22% each year from 2011 to 2015. One of the biscuits favoured by the public is the coconut biscuit. Coconut biscuits have a savoury taste due to the addition of coconut flour, which makes them popular.

Currently, on coconut biscuit packaging presents several significant issues that require improvement. These biscuits are typically packaged in thin plastic, which can cause the product to be easily crushed. The packaging lacks a resealable feature, making storage inconvenient and exposing the biscuits to bacterial contamination, and the packaging design is less appealing, which may reduce the product's attractiveness to consumers. Meanwhile, the general function of packaging is to protect and secure the contents of the product, shielding it from factors that can be harmful and reduce the quality of the product, such as UV radiation, humidity, shocks, dirt, and bacterial contamination (Anasrulloh & Basiron, 2022).

In the current era of globalization, packaging is not only a protective barrier but also a key factor in enhancing a product's marketability and brand image (Mashadi & Munawar, 2021). Visually appealing packaging that effectively represents the product will encourage consumers to make impulsive purchasing decisions (Mufreni, 2016). There are several packaging indicators that consumers can consider when making a purchasing decision for a product, namely the packaging material, packaging appearance, packaging shape, and the information contained on the packaging (Fitriani & Nugraha, 2024). The design concept of the coconut biscuit packaging, which currently has shortcomings, needs to be planned carefully to preserve its market value and enhance consumer interest. Based on survey data conducted on 52 respondents, with a percentage of 74.1%, it shows that the coconut biscuit packaging needs to be planned.

The first step in the packaging improvement stage is establishing the design concept. The packaging design concept aims to showcase the product's identity and unique characteristics (Isna et al., 2024). Producers can use packaging design concepts derived from consumers' emotional reactions to enhance their product image. This is useful for creating packaging designs that meet customer demands and preferences; these design concepts can also be linked to design components and consumer opinions about the packaging (Delfitriani et al., 2022). Additionally, the design concept serves as a communication medium between the consumer and the product (Zulkarnain, 2020). Therefore, in creating packaging, the process of planning the design concept becomes very important.

The method used for planning the design of coconut biscuit packaging is the Kansei Engineering method. Kansei Engineering is a method capable of interpreting consumer feelings and perceptions, namely sight, hearing, smell, taste, and touch, into design specifications (Vilano & Budi, 2020). This method allows for the simulation of client sentiments and emotions, which are then transformed into design specifications (Fadly & Satori, 2021). The use of the Kansei Engineering method aims to capture the feelings and emotions of consumers (Thesman & Rahardjo, 2017). In planning the coconut biscuit packaging design concept, feelings and emotions are required, as consumers will choose attractive packaging based on their feelings and emotions. Therefore, it is essential to plan the coconut biscuit packaging concept using the Kansei Engineering method to ensure an effective design.

Several studies on packaging improvement that have successfully implemented Kansei Engineering include research on the design of fish cracker packaging (Fathimahhayati et al., 2019). Observations show that consumers prefer plastic packaging with digital printing and vibrant designs featuring more than three colors. A similar study on the planning of processed snack packaging design at the Central Java MSME Center (Nugroho et al., 2017). The resulting packaging concepts are adorable and simple. Then, the packaging design concept for the Lealoe product will be developed (Delfitriani et al., 2023). The research produced four design ideas, namely eye-catching, natural, simple, and eco-friendly. Another study is the redesign planning of tambang cake packaging at UMKM Sumber Jaya (Yasin et al., 2024). The research produced a packaging concept with a single colour, a non-ziplock closure type, a standing pouch structure, and packaging images using tambang cake icons. The research demonstrates the effective application of the Kansei Engineering method in packaging development, as it successfully translates consumer emotions and preferences into design concepts. Hence, this research also uses the Kansei Engineering method.

The supporting method applied to process and translate the obtained Kansei Word data is the Principal Component Analysis (PCA) method. The PCA method is used to understand the obtained Kansei words in a tangible way to determine the exposure of participants' responses to the appropriate design concepts (Bhayukusuma & Hadiana, 2021). Principal Component Analysis can help interpret the feelings of Kansei Word in a tangible manner based on the statements of loyal product respondents (Isa & Hadiana, 2017).

This research aims to plan the concept of coconut biscuit packaging design that aligns with consumer priorities, thereby meeting the desired criteria. The designed packaging will ultimately produce packaging that matches consumer preferences. It is hoped that the packaging designed in this research can create added value so that the product can compete with other products, thereby increasing its market value.

2. MATERIALS AND METHODS

This research uses the Kansei Engineering method supported by the Principal Component Analysis method (PCA). The following are the stages in this research illustrated with a flowchart as shown in Figure 1.

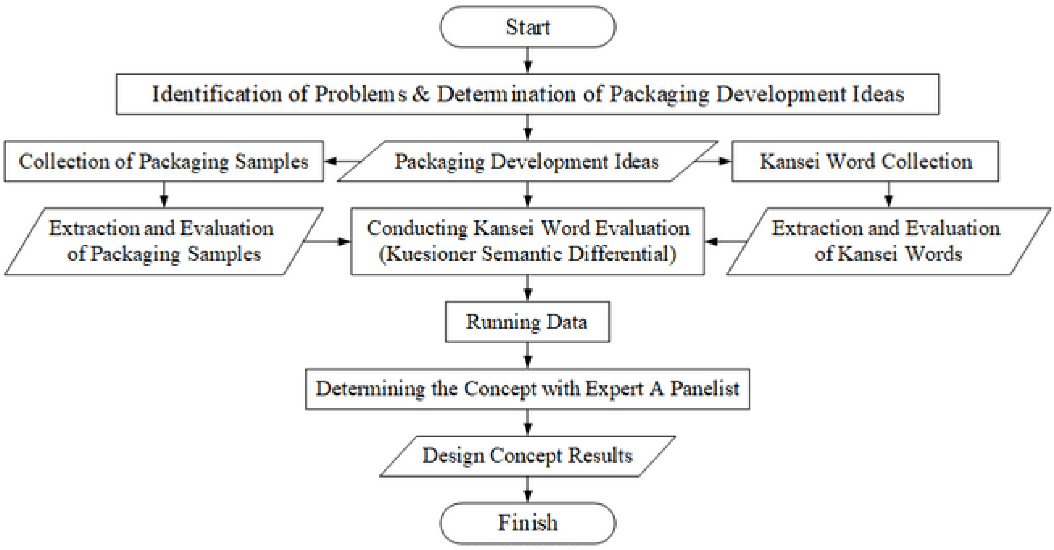

Figure 1. Kansei Engineering Method Process Stages

2.1. Identification of Problems and Determination of Packaging Development Ideas

The first stage in packaging planning and development involves identifying issues present in the packaging that have received complaints (Isna et al., 2024). Problem identification and idea determination are carried out through survey observations of coconut biscuit consumers to identify important issues in redesigning the packaging.

2.2. Collection of Packaging Sample

After determining the packaging development idea, a Segmentation Targeting and Positioning analysis is conducted to determine respondents' packaging sample and Purposive Judgment Sampling. Purposive Judgment Sampling is a sampling method based on the researcher's assessment of who meets the criteria to be used as samples (Istiyanto & Nugroho, 2017). The collected packaging samples are based on packaging that can be applied to coconut biscuit packaging. The collection of samples needed for Kansei research is at least 20-25 different samples (Putri et al., 2024). Samples are collected by gathering packaging references available in the market via various social media platforms such as Pinterest, Google, and other internet sites (Firdaus & Sari, 2024). The samples that have been collected will be initially selected based on material, shape, and design, which includes size, features, colour, and font type (Lamalouk & Simanjuntak, 2023).

2.3. Collection of Kansei Words

Kansei words are obtained from interviews by providing questionnaires to consumers that contain issues related to coconut biscuit products, consumer expectations, and consumer impressions of the product. At the stage of collecting Kansei words, a video stimulus was used to explain the product using packaging samples to explore consumers' emotions towards the product (Isna et al., 2024). The number of Kansei words collected usually ranges from 50 to 600 words before being selected (Putri et al., 2024). The collected Kansei words are then selected by experts into various Kansei words with precise meanings, forming several groups (Arini et al., 2023). In the Kansei Engineering method, there is no minimum number of Kansei words, but it is recommended to be between 15 and 30 (Kodžoman et al., 2023).

2.4. Kansei Word Evaluation

The Kansei word evaluation stage is carried out using a Semantic Differential questionnaire to assess Kansei words. The Semantic Differential contains opposing words, both positive and negative, grouped on a seven-point scale (-3, -2, -1, 0, 1, 2, 3) (Isna et al., 2024). The results from the questionnaire are entered into Excel, and then the data is converted into Notepad to be run using R software (Putri et al., 2024).

2.5. Processing Data Using PCA in R Software

PCA data processing using R software to identify the data groupings from the Semantic Differential questionnaire results (Nasution, 2020). The PCA data processing results in a Kansei word distribution graph, a scree plot graph, and a standard deviation. The process of processing Kansei words is used to establish ideas made from groups of Kansei words (Putri et al., 2024).

2.6. Determining The Concept

The process of determining the concept is carried out through discussions by an Expert Panel consisting of specialists in packaging design with over 10 years of experience to produce a concept suitable for coconut biscuit packaging (Firdaus & Sari, 2024). Based on the packaging samples, an analysis of the relationship between packaging elements and design ideas is conducted (Putri et al., 2024).

3. RESULTS AND DISCUSSION

The planning of the coconut biscuit packaging concept applies the Kansei Engineering method. The planning process involves identifying the problem, gathering selected samples, determining the Kansei words, inputting PCA data using R software, and establishing the packaging concept.

3.1. Identification of Problems and Determination of Packaging Development Ideas

The process of problem identification and the determination of the packaging development concept for coconut biscuits was conducted by surveying 52 respondents who are consumers of coconut biscuits. The results obtained show that 20.4% of the respondents consider it necessary, and 74.1% consider it very important to plan and develop the packaging for coconut biscuits.

3.2. Collection of Packaging Samples

The packaging samples obtained through social media platforms such as Pinterest and Google amount to 70 samples. The samples that have been collected will first be selected based on material, shape, and design, including colour and type, size, and features (Lamalouk & Simanjuntak, 2023). After the selection process, 59 selected packaging samples were obtained, as shown in Table 1.

Table 1. Selected Packaging Samples

3.3. Collection of Kansei Words

Kansei words are representations from respondents regarding a product that are used to translate emotions and feelings into the structure of product components (Anwar, 2024). The technique for collecting Kansei words was obtained through interviews by providing questionnaires to 52 respondents. The number of 52 respondents met the minimum data sufficiency requirement, which is more than or equal to 30 respondents (Sari, Hafidah, et al., 2023). The Kansei words obtained were 615 words, which were then divided into two parts: Kansei words and characteristic design. The Kansei words obtained were 47 words along with their antonyms, as shown in Table 2. The distinctive design was then further divided into several parts: material, structure, design, and features, as shown in Table 3. Characteristic design functions as a unification of form, structure, material, colour, typographic image, and information with design elements to generate a concept from measuring consumer emotions (Maflahah et al., 2023). Therefore, characteristic design is applied to help determine the idea of coconut biscuit packaging design that can meet and reflect consumer preferences and tastes so that the packaging not only attracts attention but also aligns with existing market expectations and needs.

Table 2. Kansei Words

KANSEI WORD					
No.	Kansei Word	Antonym	No.	Kansei Word	Antonym
1.	Sweet Design	Design is not cute	25.	Easy to care	Hard to care
2.	Easy to open	Difficult to open	26.	Disposable	Reusable
3.	Hygienic	Unhygienic	27.	Elegant	Not elegant
4.	Easy to hold	Hard to hold	28.	Informative	Not informative
5.	Transparent	Not transparent	29.	Colorful	Not colorful
6.	Proportional	Not proportional	30.	Can stand	Unable to stand
7.	Practical	Not practical	31.	Attractive	Not attractive
8.	Strong material	Material is not strong	32.	Beautiful design	Design is not beautiful
9.	Reusable	Disposable	33.	Safety	Not safety
10.	Light material	Heavy material	34.	Design crunchy	Design is not crunchy
11.	Neat	Not neat	35.	Design describes fragrance	Design is not describes fragrance
12.	Easy to take	Hard to take	36.	Eye catching	Not eye catching
13.	Air-tight	Not air-tight	37.	Thick	Thin
14.	Cover	No cover	38.	Durable	Not durable
15.	Ergonomic	Not ergonomic	39.	Eco friendly	Not eco friendly
16.	Easy to close	Hard to close	40.	Thin	Thick
17.	Sturdy	Not sturdy	41.	Exclusive	Not exclusive
18.	Food grade	Not food grade	42.	Efficient	Not efficient
19.	Easy to store	Hard to stop	43.	Inert material	Non-inert material
20.	Good design	Design is not good	44.	Cute packaging	Packaging is not cute
21.	Tasty	Not tasty	45.	Functional	Not functional
22.	Unique	Not unique	46.	Minimalist	Not minimalist
23.	Round	Not round	47.	Protective	Not protective
24.	Simple	Not simple			

Table 3. Characteristic Design

DESIGN CHARACTERISTICS			
Material	Structure	Design	Feature
Plastic	Tube packaging	Illustrative	Having a window
Craft	Jar	Pale yellow	Easy to open
Cardboard	Pouches	Golden	Easy to grasp
Paper	Folding box	Chocolate	Ergonomics
Duplex	Round	Golden brown	There is a pull cord.
Alumunium foil	Can shaped	Light brown	Ziplock
Can	Shaped packaging Coconut	Coconut illustration	Tear notches
Air-tight		Colorful	Easy to take
Food grade		Cream	Paper clip
Inert		Pale brown	There is an inner
		Red in color	Easy to store
		Biscuit illustration	There is a cover
		Informative	Functional
		Milk illustration	Easy to close
		Soft color	Can be stored
		Brownish yellow	Can be closed
		Gradation	Easy to carry
		Matte color	Packaging can stand
		Luxurious	Retractable packaging
		Children	Can be used as a container
		Bright design	The contents of the product can be viewed
		Soft yellow	Packaging can be pushed
		Coconut illustration	
		Product identity	
		Minimalist	
		Fine	
		Fine yellow	
		Eye catching	
		Bright design	

3.4. Kansei Word Evaluation

The 47 Kansei words were subsequently re-evaluated to assess the correlation between the Kansei words and the 59 samples obtained, as shown in Table 1. This evaluation process was conducted using a Semantic Differential questionnaire with a 7-point scale ranging from -3, -2, -1, 0, 1, 2, 3, involving 30 respondents selected through Purposive Judgment Sampling. In accordance with the research objectives, the respondents were chosen through Purposive Judgment Sampling. The questionnaire used in this study consists of 59 questions, with each question evaluating 59 different samples. It encompasses 47 Kansei words designed to measure respondents' perceptions and emotions related to the product being studied. The method for filling out the questionnaire can be seen in Figure 2.

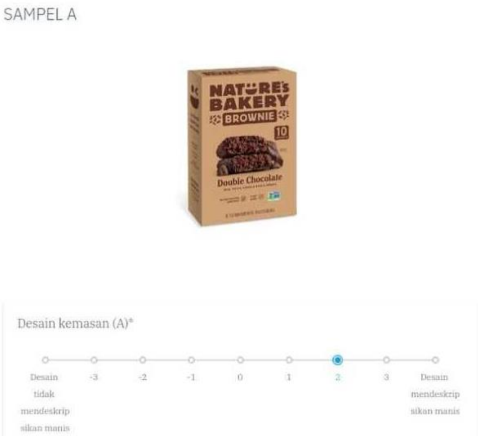

Figure 2. Semantic Differential Questionnaire

3.5. Processing Data Using PCA in R Software

PCA data processing using R software identified one Principal Component (PC) to be retained. This number was obtained using the following method.

3.5.1. Graphics Plot Scree

The scree plot is analyzed based on the slope of the component points (Sari, Imam, et al., 2023). In Figure 3, it can be observed that there is a very steep slope at component point 1, indicating that this component has a significant contribution in explaining data variability. Thus, PC 1 is retained as it significantly explains data variability.

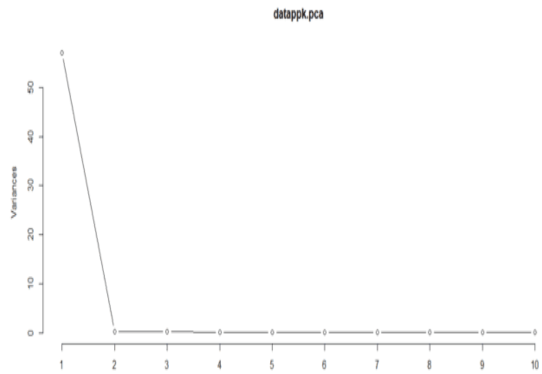

Figure 3. Graphics Plot Scree

3.5.2. Standard Deviation

The results of PCA data processing show that PC 1 has the highest standard deviation of 7.5565. Figure 4 illustrates that only one component has a standard deviation greater than 1. Thus, only one component is retained, as it significantly contributes to data variation (Sari et al., 2020).

```
Importance of components:
                          PC1     PC2     PC3     PC4     PC5
Standard deviation     7.5565 0.49612 0.47076 0.34909 0.32190
Proportion of Variance 0.9678 0.00417 0.00376 0.00207 0.00176
Cumulative Proportion  0.9678 0.97198 0.97574 0.97781 0.97956
                           PC8    PC9    PC10    PC11    PC12
Standard deviation     0.26404 0.2553 0.24517 0.23794 0.22517
Proportion of Variance 0.00118 0.0011 0.00102 0.00096 0.00086
Cumulative Proportion  0.98370 0.9848 0.98582 0.98678 0.98764
                          PC15    PC16    PC17    PC18    PC19
Standard deviation     0.21047 0.20488 0.19824 0.18926 0.18255
Proportion of Variance 0.00075 0.00071 0.00067 0.00061 0.00056
Cumulative Proportion  0.99003 0.99074 0.99141 0.99202 0.99258
                          PC22    PC23    PC24    PC25    PC26
Standard deviation     0.17014 0.16789 0.16301 0.15263 0.14585
Proportion of Variance 0.00049 0.00048 0.00045 0.00039 0.00036
Cumulative Proportion  0.99412 0.99460 0.99505 0.99545 0.99581
                          PC29    PC30    PC31    PC32    PC33
Standard deviation     0.13754 0.13072 0.12410 0.12103 0.11508
Proportion of Variance 0.00032 0.00029 0.00026 0.00025 0.00022
Cumulative Proportion  0.99680 0.99709 0.99735 0.99760 0.99782
                          PC36    PC37    PC38    PC39    PC40
Standard deviation     0.10330 0.09658 0.09468 0.08967 0.08821
Proportion of Variance 0.00018 0.00016 0.00015 0.00014 0.00013
Cumulative Proportion  0.99840 0.99855 0.99871 0.99884 0.99897
```

Figure 4. Standard Deviation Results

3.5.3. Cumulative of Proportion (of Variance)

The cumulative proportion of variance for PC 1 is 96.78%. This value significantly exceeds the 70%–80% threshold, demonstrating that PC 1 effectively captures most data variation and represents the dataset's main characteristics (Mas'ad et al., 2016). The Cumulative Proportion results can be seen in Figure 5.

```
Importance of components:
                          PC1     PC2     PC3     PC4     PC5
Standard deviation     7.5565 0.49612 0.47076 0.34909 0.32190
Proportion of Variance 0.9678 0.00417 0.00376 0.00207 0.00176
Cumulative Proportion  0.9678 0.97198 0.97574 0.97781 0.97956
                           PC8    PC9    PC10    PC11    PC12
Standard deviation     0.26404 0.2553 0.24517 0.23794 0.22517
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                          PC15    PC16    PC17    PC18    PC19
Standard deviation     0.21047 0.20488 0.19824 0.18926 0.18255
Proportion of Variance 0.00075 0.00071 0.00067 0.00061 0.00056
Cumulative Proportion  0.99003 0.99074 0.99141 0.99202 0.99258
                          PC22    PC23    PC24    PC25    PC26
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Proportion of Variance 0.00049 0.00048 0.00045 0.00039 0.00036
Cumulative Proportion  0.99412 0.99460 0.99505 0.99545 0.99581
                          PC29    PC30    PC31    PC32    PC33
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                          PC36    PC37    PC38    PC39    PC40
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Proportion of Variance 0.00018 0.00016 0.00015 0.00014 0.00013
Cumulative Proportion  0.99840 0.99855 0.99871 0.99884 0.99897
```

Figure 5. Cumulative Proportion Results

3.5.4. Kaiser Method

The Kaiser method identifies principal components with variance values above 1 in R software (Coghlan, 2014). Based on the results obtained in Figure 6, it shows that PC 1 has a value above 1, which is 5.710. Therefore, in this study, PC 1 is retained.

```
> screeplot(datappk.pca, type="lines")
> (datappk.pca$sdev)^2
 [1] 5.710095e+01 2.461367e-01 2.216110e-01 1.218633e-01
 [6] 9.224759e-02 8.216052e-02 6.971759e-02 6.517954e-02
[11] 5.661360e-02 5.070355e-02 4.925101e-02 4.744645e-02
[16] 4.197437e-02 3.929834e-02 3.582092e-02 3.332422e-02
[21] 3.019127e-02 2.894851e-02 2.818722e-02 2.657264e-02
[26] 2.127182e-02 2.013752e-02 1.947378e-02 1.891803e-02
[31] 1.539977e-02 1.464927e-02 1.324385e-02 1.235365e-02
[36] 1.067149e-02 9.327211e-03 8.963906e-03 8.040593e-03
[41] 7.196381e-03 6.472604e-03 5.660737e-03 5.154604e-03
[46] 4.612549e-03 4.115700e-03 3.528797e-03 3.213257e-03
[51] 2.383849e-03 2.175203e-03 1.925268e-03 1.710173e-03
[56] 1.405231e-03 9.697711e-04 5.974518e-04 5.448583e-31
```

Figure 6. Variation Value Result

3.6. Determining The Concept

After determining how many main components are retained, the Kansei words that appear on PC 1 are described in the positive and negative quadrants, as shown in Figure 7. To define the design concept, we analyze the Kansei word distribution across quadrants, as it reflects consumer perceptions and emotional responses (Sari, Hafidah, et al., 2023). Paired principal components (PCs) show a diagonal correlation at 180° (Coghlan, 2014). Figure 7 visually maps the Kansei word distribution from PCA analysis in R software. The placement of words along the PC 1 axes helps identify key emotional and perceptual attributes influencing the design concept.

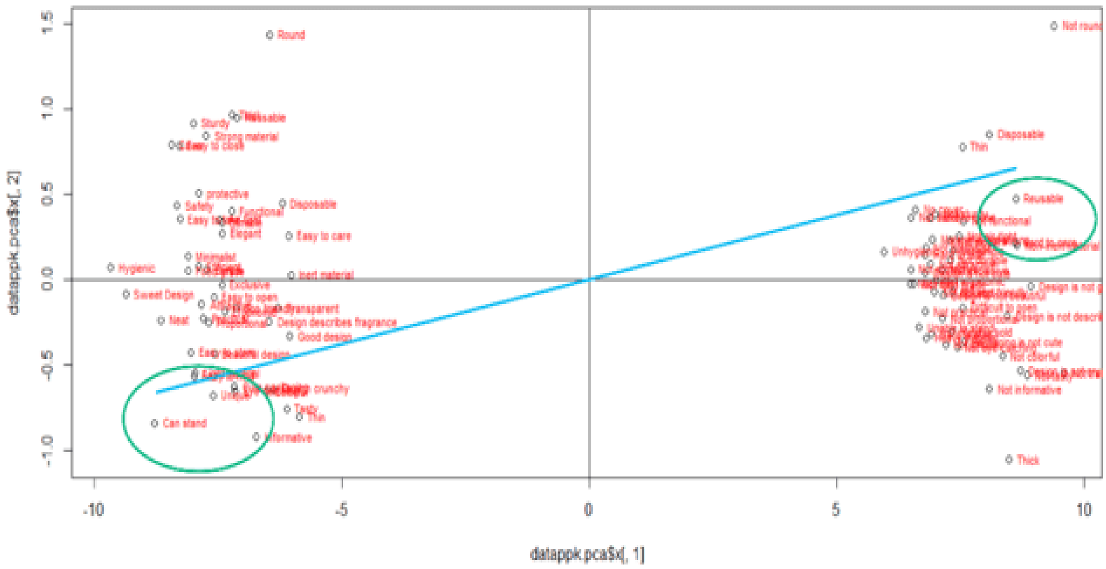

Figure 7. Kansei Word Distribution Map in R Software

Following a discussion with an expert in packaging design, a design concept was developed based on the distribution of Kansei words. The Kansei words that emerged on the PC 1 axis in the positive quadrant are standable packaging, lightweight material, easy to grip, unique, and informative, so PC 1 in the positive quadrant is interpreted as the "Ergonomic" concept. Conversely, the negative quadrant of PC 1 includes Kansei words such as not single-use, non-simple packaging, and non-minimalist design, which define the 'Complex' concept. Thus, the two viable design concepts for coconut biscuit packaging are 'Ergonomic' and 'Complex'.

4. CONCLUSIONS AND RECOMMENDATIONS

This research develops an innovative packaging concept for coconut biscuits, enhancing both visual appeal and functionality to match consumer preferences. The development of this product packaging uses the Kansei Engineering method, and the design concept is determined using Principal Component Analysis (PCA). This study analyzed 59 coconut biscuit packaging samples, from which 47 Kansei words were identified. The Kansei words obtained were evaluated using a Semantic Differential questionnaire given to 30 coconut biscuit consumers, and the results of the questionnaire were processed using R software. PCA analysis using R software identified a single design concept (PC 1) with a standard deviation of 7.5565, a Cumulative Proportion of 96.78%, and a variance of 5.710, defining the 'Ergonomic-Complex' concept. A key limitation of this study is that the design concept is derived from existing packaging samples, which may result in a design similar to current market offerings. Future research should explore more diverse packaging inspirations to enhance innovation.

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