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Research

Survey on The Salt Usage Among Fish Cracker (Keropok Lekor) Manufacturers in Several Districts of Kuala Terengganu, Malaysia

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ABSTRACT

Fish crackers (*keropok lekor*) are known for their tastiness. Although rich in protein and iodine, it contains a high amount of salt or sodium. Therefore, this study aimed to determine the manufacturers' practice in the preparation of keropok lekor, perception and challenges concerning salt usage, and motivation to reduce salt content. This study also aimed to estimate the sodium content in *keropok lekor*. Seven manufacturers of *keropok lekor* in Terengganu were interviewed either face-to-face or online to obtain relevant information. All interviews were recorded, transcribed, and analyzed based on a thematic analysis framework. The recipes of *keropok lekor* were analyzed using the Nutritionist Pro software to determine the nutritional and sodium content, calculated based on the Malaysian and ASEAN Food Composition Tables. Based on the interviews, most manufacturers (90%) supported the effort to reduce salt in *keropok lekor*. However, the effort was met with several challenges, such as customer acceptance and negative perception of the taste, decreased sales, and increased material costs. The enabling factors include maintaining the original flavor of *keropok lekor*, customer requests, marketing opportunities, and the availability of salt substitutes. Support for marketing and financial technology know-how is also necessary. An estimate of 606.43 mg/100g of sodium content in *keropok lekor* was obtained in this study, which was mainly derived from the usage of sodium chloride and monosodium glutamate (MSG) during the preparation. This study revealed the high salt content in *keropok lekor* due to the addition of salt and seasonings. There is a potential to reduce salt content in *keropok lekor* with appropriate support provided to the manufacturers. Nevertheless, further research is needed to produce *keropok lekor* with reduced salt content, improved sensory, and enhanced microbial and physicochemical characteristics, which can improve customer perception.

Key words: Fish crackers, food reformulation, keropok lekor, perception, reduced salt, salt

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INTRODUCTION

Salt is widely used in the food processing industry due to its availability and versatility for various purposes, including as a seasoning, preservative, and additive to influence protein behavior (Rysová *et al*., 2021). In addition to sodium chloride (salt), sodium can also be derived from various sources, such as monosodium glutamate (MSG) in seasoning cubes and preservatives, including sodium nitrate and sodium benzoate. Excessive salt intake can increase blood pressure and the associated risk of cardiovascular diseases, such as heart attack and stroke (Harun *et al*., 2023). Salt intake among Malaysians has exceeded the recommended daily intake of less than one teaspoon (equivalent to 2000 mg of sodium) set by the World Health Organization (2012). Common sources of salt include the salt added in cooking, sauces, seasonings, or processed products (Ambak *et al*., 2021). Based on the National Health and Morbidity Survey (NHMS) 2019, 30% or 6.4 million Malaysians suffer from hypertension. To prevent non-communicable diseases, WHO

has proposed a salt reduction intervention strategy and set a global target to reduce the population's salt intake by 30% in 2025.

Keropok lekor is one of the traditional fish-based snacks that are popular, especially on the East Coast of Peninsular Malaysia, i.e., Terengganu. It is also widely sold throughout Malaysia, especially at roadside stalls and night markets. *Keropok lekor* is made from the flesh of seafish mixed with sago flour, salt, MSG, sugar, and ice-cold water (Wan Md. Hatta, 2015). The high content of fish makes this fish-based snack rich in protein and natural iodine. However, fish-based snacks including *keropok lekor* have been associated with high salt content (Institute for Medical Research, 2015; Haron *et al*., 2022). Controlling salt intake becomes challenging for people who eat outside or enjoy processed food. Moreover, most processed food products do not display their salt content on the label for nutritional facts, which consumers can refer to (Hasnah *et al*., 2020).

Salt reduction strategies and interventions have been outlined in response to the urge by the WHO to reduce salt intake among the population. Among the key strategies are to involve manufacturers of food products and other associated products (product labels) and to invoke product reformulation. Product reformulation is the process of changing the recipe or composition of food products or beverages (Scott *et al*., 2017). The food and beverage industry typically undertakes product reformulation to improve taste and reduce production costs. Product reformulation for improving health benefits has also been carried out widely following the recommendation by the WHO (Van Raaij *et al*., 2009). Manufacturers agree that reformulating recipes is one of the effective measures to reduce the rate of salt consumption, which has been practiced in several countries (Hyseni *et al*., 2017).

However, manufacturers have pointed out several challenges associated with reducing salt content in food products, which is predominantly due to its versatile uses beyond food seasoning. For example, salt also acts as a natural preservative, which controls water activity and thus prevents bacterial growth. In addition to improving the taste of *keropok lekor*, salt ensures the quality of fish-based crackers (Taewee, 2011). In Malaysia, studies on consumer perception of *keropok lekor* prepared with spices as seasoning ingredients have revealed a generally positive response among consumers (Omar *et al*., 2011; Irfan Uddin *et al*., 2019). These studies demonstrate customer acceptance of alternative flavors or formulations of *keropok lekor*. However, there is no study conducted to review the use of salt from the perception of *keropok lekor* manufacturers. Therefore, this study was conducted to survey the uses and sources of salt in the manufacturing process and to obtain the point of view of *keropok lekor* manufacturers in Terengganu regarding the reformulation of *keropok lekor* with reduced salt content.

MATERIALS AND METHODS

Study design and sampling

A mixed method of observation and qualitative study involving participants comprised *keropok lekor* manufacturers from four districts in Terengganu (Kuala Terengganu, Besut, Setiu, & Marang). This study was part of a larger project on “Developing a policy to reduce the salt content of food consumed outside the home in Malaysia,” involving all formal and informal sectors.

The inclusion criteria were small-scale manufacturers of *keropok lekor* that have been operating for more than two years and were willing to share their *keropok lekor* formulation. Terengganu was chosen because it is a state that is synonymous with the *keropok lekor* industry and is considered the origin of the production of *keropok lekor* in Malaysia (Aqil, 2020).

Potential *keropok lekor* manufacturers who met the inclusion criteria were invited to participate in the study via email or phone call. They were briefed on the purpose of the study. Only eligible manufacturers received a written invitation via email or WhatsApp for a subsequent in-depth interview, along with information and consent forms. Participants were informed about the confidentiality of the study. Only respondents who voluntarily signed the consent form were allowed to participate in the interview.

Data collection

This study was approved by the Universiti Kebangsaan Malaysia Research and Ethics Committee (MREC) with a UKM approval number of JEP-2022-148. Data collection was conducted from April to June 2022 in Terengganu through an in-depth interview method, i.e., face-to-face, video call, or phone call. Each session took 30 to 90 min. The interviews were conducted by a trained interviewer (researcher) who followed a predefined procedure and questionnaire. The interviewer began with a brief introduction to the research. The interviewer requested the respondent to place their camera in ON mode and made sure the microphone was working. The interviewer concluded the session by highlighting major topics raised by the respondents. The sessions were recorded using voice and video

recorders with permission obtained from the respondents. Each respondent was assigned to a code, such as P1, P1, P3, and so on to ensure confidentiality. Open-ended semi-structured questions that have been divided based on themes with questions related to the objectives of the study were used to facilitate the interview session.

The questionnaire

The questionnaire used in this study was developed based on a combination of frameworks modified from the Medical Research Council (MRC), United Kingdom, Ecological Model, and Theoretical Domains Framework (TDF). The development and feasibility domains from the MRC made up the basic framework, whereas the Ecological Model and TDF were adopted to refine the development process consisting of specific domains to answer the research question, as described by Brown *et al*. (2021) with slight modification to meet the objective of this study. The questionnaire consisted of a sociodemographic section and six other sections: 1) information on *keropok lekor* production; 2) perception, norm, and culture; 3) practice and action in the formulation of *keropok lekor*; 4) challenges and barriers; 5) participation in the reformulation of *keropok lekor*; 6) suggestions. The questionnaire was structured using open-ended questions in Malay language.

Determination of nutrient content in *keropok lekor*

Nutrient contents of the *keropok lekor* were determined using Nutritionist ProTM Software. The nutrient contents in the *keropok lekor* were estimated based on the information on the ingredients (percentage by weight) disclosed by the manufacturers during the interview. The nutrient contents of the *keropok lekor* were calculated according to the Malaysian Food Composition Table (Institute for Medical Research, 2015), the ASEAN Composition Table Institute of Nutrition, Mahidol University (2014), or any available product label.

Data analysis

Audio recordings from the interview sessions were converted into text to obtain verbal and non-verbal (text) data. The transcribed responses were subsequently analyzed using NVivo computer software version 12 (QSR International, Doncaster, Victoria, Australia). The thematic framework was applied to classify and organize data based on theme keywords. Additionally, nutrient contents were estimated using Nutritionist Pro software (Axxya Systems LLC, Washington, USA) based on the recipe shared by *keropok lekor* manufacturers. The value of these nutrients was calculated based on the Malaysian Food Composition Database (Institute for Medical Research, 2015), the ASEAN composition database (U.S. Department of Agriculture, 2019), or the product label (if any).

RESULTS

A total of 18 small *keropok lekor* manufacturers were invited but only seven agreed to participate in this study (response rate of 39%). Out of seven *keropok lekor* manufacturers interviewed, six were males and only one was female. All manufacturers were Malay, and most manufacturers were between 30 and 40 years old. In addition, two manufacturers have more than ten years of experience in the making of *keropok lekor*. All manufacturers were categorized as small-scale manufacturers.

The process of making *keropok lekor*

All manufacturers undertake a similar process for the making of *keropok lekor*. Generally, *keropok lekor* production involves multiple stages including the preparation of fish, mixing of ingredients, dough preparation, from shaping to boiling, and deep frying of the final product (Figure 1).

The fish is first cleaned and the flesh is removed from the bone and homogenized using a blender. For operators using ready-to-use fish flesh, the process starts with thawing the flesh, followed by crushing in a grinder. Salt, sugar, and flavor enhancers are mixed with the minced fish flesh, with some ice cubes. The sago flour (or a mixture of sago and starch) is added to the minced fish flesh to form a dough of the right consistency. The dough is then weighed to obtain a uniform size and rolled into a cylindrical shape using a shaping machine or traditional method.

Next, the shaped dough is boiled to ensure freshness and prolong the shelf life of *keropok lekor*. Once floated, the *keropok lekor* is deemed ready to be taken out. The boiling time depends on the quantity and thickness of the *keropok lekor*. In addition, boiled *keropok lekor* is left to drain and vacuum-packed before being stored in the freezer to prolong its shelf life. Boiled *keropok lekor* is usually ready to eat without the need for frying. However, the frying process is undertaken to get a texture of *keropok*

lekor that is crispy on the outside and soft on the inside.

Fig. 1. *Keropok lekor* production. (a) Separating the fish fillet from the bone (deboning), (b) crushing frozen fish fillet, (c) mixing of ingredients, (d) shaping and rolling of dough to form *keropok lekor*, (e) boiling the keropok lekor, (f) frying the keropok lekor.

Ingredients and sources of sodium in the process of preparing *keropok lekor*

Among the main ingredients in the production of *keropok lekor* by the manufacturers in Terengganu are fish flesh (Mackerel Scad/Indian Mackerel/Sardine Nella/Wolf Herring, etc.), sago flour, and seasonings, e.g., salt, monosodium glutamate (MSG), and sugar. Additionally, manufacturers may add other ingredients to the *keropok lekor*, such as starch (cassava starch/corn starch), Surimi Plus +300 (Soy Asahi Sdn. Bhd.), sodium bicarbonate, baking powder, and cooking oil. Table 1 shows the estimated nutrient contents in raw *keropok lekor* based on each manufacturer's formulation using Nutritionist Pro software. On average, the sodium content in *keropok lekor* was 606.43 ± 165.31 mg per 100 g, which is considered a high sodium category (600 mg per 100 g) according to the Food Standards Agency (2016). The analysis also revealed a few sources of sodium, including salt (sodium chloride), flavor enhancers, e.g., MSG, and baking ingredients, e.g., bicarbonate of soda and baking powder. It was also found that fish and flour contain low and medium amounts of sodium. The estimated percentage of sodium based on the analysis of *keropok lekor* recipes showed that almost 80 percent of sodium content is derived from salt (sodium chloride) and seasonings, e.g., MSG.

Perceptions of *keropok lekor* manufacturers on *keropok lekor* with less salt

Themes/sub-themes have been generated on perceptions of the participants on reduced salt *keropok lekor* as summarized in Table 2.

Perceptions toward salt reduction effort in *keropok lekor* preparation

Most of the respondents acknowledged that excessive salt intake is often associated with hypertension and is bad for health. In terms of the usage of salt in the preparation of *keropok lekor*, most manufacturers stated that salt is one of the important ingredients for maintaining the taste and believed that the amount used in *keropok lekor* is sufficient and not excessive. The manufacturers believed in the idea of producing *keropok lekor* with reduced salt as it is only used as a seasoning in the preparation of *keropok lekor*. Furthermore, *keropok lekor* is usually eaten with sauce. However, one manufacturer argued that reducing salt in *keropok lekor* would compromise its taste as salt is an important flavoring ingredient compared to sugar (Nordin, *et al*., 2018).

Table 1. The estimated nutritional content of *keropok lekor* (100 g) produced by the small-scale manufacturers

Nutrition	P1[a]	P2[a]	P3[a]	P4[a]	P5[a]	P5[b]	P6[a]	P6[b]	P7[a]	Average ± SD
Calorie (Kcal)	189.31	189.79	189.44	179.49	190.27	229.55	188.63	231.30	231.96	202.19 ± 21.81
Carbohydrate (g)	29.47	25.11	29.27	25.41	29.32	43.60	29.12	45.03	44.64	33.44 ± 8.41
Protein (g)	14.32	15.43	14.51	15.60	14.63	11.04	14.46	10.29	10.70	13.44 ± 2.13
Fat (g)	1.53	3.03	1.55	1.67	1.57	1.18	1.55	1.10	1.14	1.59 ± 0.58
Sodium (mg)	*691.72	389.79	*790.49	*580.23	431.41	431.45	*567.00	812.17	763.64	606.43 ± 165.31
Potassium (mg)	219.88	236.45	221.87	238.34	224.55	170.66	221.63	159.20	164.08	206.30 ± 32.02
Magnesium (mg)	0.09	0.00	0.00	0.00	0.00	0.00	0.17	0.09	0.00	0.04 ± 0.063
Calcium (mg)	82.59	88.46	83.47	89.06	84.40	66.36	83.20	83.06	66.71	80.81 ± 8.43

[a]Original *keropok lekor*, [b]Crispy *Keropok lekor*

*Sodium content may be higher because some ingredients (Hilal powder & Surimi Plus +300) do not display sodium content on the product label.

Table 2. The summary of themes/sub-themes and selected quotes based on aspects of view

Aspect of views	Theme/Sub-theme	Selected Quotes
Perception toward salt reduction effort in *keropok lekor*	**Salt intake and its effects on health**	"Salt, if it's in terms of health, it's synonymous with…high blood pressure..." (Male, 38 years old, SME#P1)
	-Hypertension	
	-Salt intake in the East Coast population is not excessive	"For me, the use of salt on the east coast is still in a stable condition so far..." (Male, 38 years old, SME#P1)
	The use and content of salt in the production of *keropok lekor*	"In the diet, if I feel it, for me the product I made, my ratio (salt) is not too high..." (Male, 36 years old, SME#P4)
	-Sufficient/Not too high/Too salty is not tasty	
		"Because the quantity of salt in my *keropok lekor* is not much. Because *keropok lekor* that is too salty is not tasty..." (Male, 36 years old, SME#P5)
	Less-salt *keropok lekor*	"I don't think it's a problem if we have it or not because the original purpose is just to add flavor, for me it's because we don't use it to make it durable or anything..." (L, 36 years old, IKS#P4)
	–The salt content can be reduced/the use of salt only as a seasoning	
	–The sauce can balance the taste	".... After all, this *keropok lekor* have sauce. If the keropok is tasteless, maybe you can balance them with sauce." (Male, 36 years old, SME#P5).
	–Not interesting	"No, not interesting. Because if you sell soup with less salt, what's the point? This salt is an important seasoning, as compared to sugar. If there is no salt, it is not possible. There must be salt. Life must have salt..." (Male, 40 years old, SME#P3)

Table 2. Countinued

Challenges or barriers to salt reduction in *Keropok lekor*	**Customer acceptance**	"The main challenge is in terms of people's acceptance of new things. If you want to make it, there is no problem because the important thing is that the *keropok lekor* has fish and sago. The rest are just seasonings..." (Male, 40 years old, SME#P3).
	Negative taste perception	"In terms of taste, one of the things we have to pay attention to is whether it tastes attractive to eat. That (*keropok lekor* with less salt) is delicious to eat..." (Male, 40 years old, SME#P3).
	Rise in cost	"If you want to change other ingredients such as salt substitutes, people are used to buying sacks because they are cheaper. But if we must deal with the price, it's a little difficult to accept..." (Male, 48 years old, SME#P6).
	Lack of awareness	"But the villagers will think that MSG is dangerous, compared to salt, right? For example, if we put a lot of MSG, people will complain…." (Male, 36 years old, SME#P5).
	Reduced sales	"...First of all, it's not tasty, and the second is the sale will be low..." (L, 38 years old, SME#P2)
Motivation to participate/ Enabling factors	**Customer's request or demand**	"...There is no problem, the important thing in the industry is that the thing can be sold.... There is demand, people want. People pay for that thing, we can make it..." (L, 40 years old, SME#P3).
	Marketing opportunities	We must highlight that thing as that thing is more for us..." (Male, 40 years old, SME#P3)
	−An advantage for the company	"If we produce a specific product that we say has more value for health, we emphasize it for marketing, right?"(Male, 36 years old, SME#P5)
	−New consumer market	"...We get another aspect of the customer. Examples of customers who do not like eating Ajinomoto and customers who want to take care of their health..." (Female, 42 years old, SME#P7).
	Able to maintain the original taste of *keropok lekor*	"...whether we want to change sodium to potassium ... and the final product does not differ with what we have now, I think that is successful for me..."(Male, 38 years old, SME#P1).
	Availability of salt substitutes	"... So, for us to try something else, we need to have that thing first (salt substitute) ..." (Male, 38 years old, SME#P1).
Support	**Promotion**	"... support for example in terms of... government agencies can do support like banners, to promote... promotion to reduce salt. To tell people to reduce salt..." (Male, 36 years old, SME#P5).
	−Promotion of less-salt *keropok lekor*/increased public awareness	"...when the government has done a campaign like that, so indirectly, people know. So, when we have reduced the salt, and people realize there is a campaign to reduce salt… so people will not complain..." (Female, 42 years old, SME#P7)
	Financial	"...the strongest support is in terms of financial, which so far I have not received or applied to any agencies..." (Male, 38 years old, SME#P1)

Practice and action of manufacturers toward salt reduction effort in *keropok lekor* preparation

In terms of practice and action, most manufacturers have never reformulated their recipes to reduce salt. However, there were two manufacturers (P3 & P4) who have tried using other types of salt such as Himalayan salt also known as pink salt instead of table salt. They pointed out that Himalayan salt contains more minerals, is cleaner, less processed, and tastes better than table salt. In addition, two manufacturers do not use the flavor enhancer, i.e., monosodium glutamate (MSG), because of the association of MSG with harmful effects on human health, apart from receiving requests from customers not to use it (Table 3). The public considers the use of MSG to be more harmful to health than salt. Therefore, the manufacturers (P3 & P4) replaced MSG with other seasonings.

Table 3. Practice and action carried out by the small-scale *keropok lekor* manufacturers

Practice and action	Example of responses
Replacing table salt with Himalayan salt ◔ Good for health ◔ Taste better	"The composition of minerals in this pink salt is good for health. And, because in terms of the industry. first, it is tastier. When we eat it, it tastes fattier..." (Male, 40 years old, SME#P3)
Replacing MSG with other seasonings ◔ Customer's request	"I am also the customer who suggested using pink salt. Usually those who recommend using this salt, also don't want us to use the MSG, because he thinks MSG is more dangerous than salt..." (Male, 36 years old, SME#P4).

Challenges or barriers

Based on interviews, there are several challenges faced by the manufacturers when reformulating products, among which are concerns about customer acceptance, lack of awareness, negative taste perceptions, increased costs, and low sales. All manufacturers pointed out that customer acceptance of something new is the main challenge to the marketing of less-salt *keropok lekor*, as customers are used to the original taste of *keropok lekor*. Manufacturers have also associated customer acceptance with taste because taste is an important element in *keropok lekor*. Low-salt products have been associated with unappealing and bland tastes, which may be received poorly by consumers, leading to the loss of customers, which indirectly reduces sales.

In addition, manufacturers have named price and cost as other challenges to producing less-salt *keropok lekor*. An increase in the cost of raw materials for the reformulation may become one of the obstacles for manufacturers to accept new recipes and change the original formulation of their *keropok lekor*. Furthermore, the cost of raw materials for *keropok lekor* has increased dramatically over the past few years, especially dry sago flour and fish flesh, which has forced manufacturers to reduce the size of *keropok lekor* or change the ingredients to cheaper ones.

Participation in salt reduction project and its enabling factors

Most manufacturers (*n*=6, 86%) expressed their interest in collaborating on salt reduction projects if they were given the opportunity and support. They also presented several factors that would encourage their participation, including customer demand, marketing opportunities, supply of raw materials (salt substitutes), and formulation for maintaining the original taste of *keropok lekor*. Customers are the main stakeholders in the *keropok lekor* industry. Therefore, the manufacturers expressed their belief that customer demand for and acceptance of *keropok lekor* prepared using salt substitutes make reducing salt in *keropok lekor* possible. Furthermore, the manufacturers also indicated that this innovation might allow their company to venture into a new consumer market by educating customers about the health benefits of their products. In addition, one operator highlighted that low-salt *keropok lekor* may attract new prospective customers, especially those who are health conscious. Besides, *keropok lekor* is one of Terengganu's traditional foods and most customers buy this product due to its taste. Therefore, the manufacturers believed that this project could be successful if the new formulation could still maintain the original taste of *keropok lekor*. Several manufacturers also expressed their readiness to reformulate the recipe of *keropok lekor* with reduced salt, should they be provided with salt substitutes.

Support needs to reduce salt in keropok lekor

Regarding suggestions for a support system, most manufacturers (*n*=5, 71%) emphasized that the parties involved, particularly the university and the government, should help in promoting the new formulation of *keropok lekor* to increase public awareness about this project. Additionally, the manufacturers highlighted the importance of emphasizing public awareness of the salt content in *keropok*

lekor and the health effects of excessive salt consumption, ensuring that people comprehend these aspects to prevent customer complaints. One manufacturer proposed financial assistance, highlighting the need for external funding. The manufacturer emphasized that their company solely relies on private capital and would greatly benefit from additional financial support from any available agency.

DISCUSSION

The use and source of sodium in the production of *keropok lekor*

In this study, the type and percentage of ingredients used differed slightly from one to another, which depends on the preference of the local community and the desired profit margin. Yet, the traditional *keropok lekor* is typically made from fish flesh, sago flour (or mixed with starch), salt, sugar, and MSG (Omar *et al*., 2011; Che Rohani *et al*., 2013). Moreover, Nordin *et al*. (2018) underscored that the higher the percentage ratio of flour to fish used in *keropok lekor*, the greater the calories and the lesser the protein. This observation came from their comparison of the nutritional composition between crispy *keropok lekor* (or called Kuala Lumpur *keropok lekor*) and *keropok lekor* originating from Terengganu. Additionally, cooking methods such as frying can also elevate the fat content in *keropok lekor* (Nordin *et al*., 2018).Sodium is primarily naturally found in sea-derived proteins, such as fish, in small or moderate amounts. According to Malaysian Food Composition Data (MyFCD), mackerel and sardine, for instance, contain 53 to 97 mg sodium per 100 g, which is equivalent to 0.1 g of salt per 100 g (Institute for Medical Research, 2015). However, the primary source of sodium in *keropok lekor* is the addition of salt and seasonings during the manufacturing process, constituting up to 80 percent of the total sodium content. Gutiérrez (2013) emphasized that salt is the most widely used additive in processed foods. Moreover, the use of sauces and the addition of cheese in street snacks like *keropok lekor* can further elevate the sodium content by as high as 55 percent (Suzana *et al*., 2019; Haron *et al*., 2022). Consequently, this can indirectly contribute to nearly 70 percent of daily sodium intake (Harnack *et al*., 2017; Ahmad *et al*., 2021).

Manufacturers typically procure salt in large quantities to capitalize on cost efficiencies. In the food processing industry, salt is widely used due to its economical pricing and versatile functionalities, serving as a seasoning and preservative, and aiding in the maintenance of quality in fish-based products by modulating protein behavior (Albarracin *et al*., 2011; Assadad & Utomo, 2011). Sources of sodium in *keropok lekor* also extend to additional ingredients, such as baking ingredients used by certain manufacturers. However, baking powder or sodium bicarbonate is commonly used in the production of instant fish-based crackers (also known as *keropok segera*), differing from *keropok lekor* (Che Rohani *et al*., 2013; Mardhiah *et al*., 2013).

During the preparation of fish flesh, some manufacturers sprinkle some salt into the ice to reduce its melting rate by lowering its freezing point (Patil & Sonawane, 2018). Subsequently, this salt-treated ice is incorporated into the fish paste mixture, which further elevates the salt content. Moreover, some manufacturers have noted that certain fish flesh suppliers incorporate salt into their processed fish flesh, making them saltier, which consequently affects the flavor of their *keropok lekor.* As a result, the manufacturers seek out suppliers who refrain from adding salt to their processed fish flesh. It is plausible that suppliers opt to add salt to the fish flesh to hinder bacterial growth and prolong the shelf life of the products (Pegg & Honikel, 2014). Nevertheless, temperature control achieved by cooling and freezing stands as a common preservation method in the fish-based industry, aimed at preventing or mitigating fish damage (Che Rohani *et al*., 2013).

The perception of *keropok lekor* manufacturers on *keropok lekor* with less salt

This study is the first to examine the perception of *keropok lekor* manufacturers regarding the effort to reduce salt content through product reformulation. The findings of this study have captured the challenges, enabling factors, and recommendations from manufacturers for producing less-salt *keropok lekor*, as summarized in Figure 2.

According to the perception of *keropok lekor* manufacturers, the use of salt in *keropok lekor* is not excessive, despite the inclusion of fish-based products like *keropok lekor* in the category of high-sodium snacks (Institute for Medical Research, 2015; Food Standard Agency, 2016; Haron *et al*., 2022). The high salt content could be derived from sources of sodium other than salt, such as food additives like sodium bicarbonate and flavor enhancers like MSG (Albarracín *et al*., 2011), which are commonly used in the manufacturing process of *keropok lekor*. In addition, some manufacturers have tried to reformulate *keropok lekor* by replacing table salt with Himalayan salt, while some have replaced MSG with other seasoning powder. These modifications are often driven by customer demand, taste preferences, and

health considerations. However, according to Tan *et al*. (2016), there is no significant difference in the sodium levels between Himalayan salt and table salt and the MSG substitutes still incorporate salt as one of the ingredients. These findings underscore the initiatives undertaken by manufacturers. However, the findings also emphasize the necessity for greater awareness within the food industry and among the public regarding the use, sources, and types of salt.

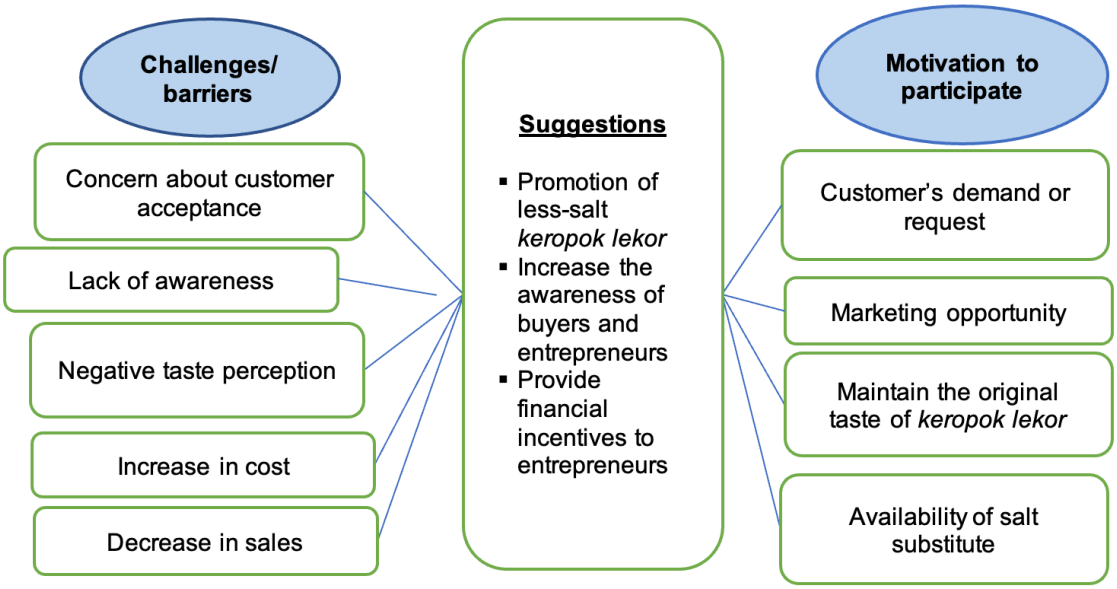

Fig. 2. Potential framework for producing *keropok lekor* with less salt

Concern about customer acceptance, lack of awareness, negative perception of the taste of less-salt *keropok lekor*, increased costs, and decreased sales are among the main challenges or barriers mentioned by manufacturers in the effort to reduce salt in *keropok lekor*. A survey conducted by the Institute of Grocery Distribution (2019) also emphasized that one of the main challenges in product reformulation in Malaysia is to maintain the authenticity of taste and customer acceptance. Reducing nutrients like salt that contribute to the taste of food or beverages without compromising consumer preference poses a significant challenge in product reformulation efforts. Taste is an essential element in food products and plays a vital role in determining customer acceptance (Buttriss, 2013). In another qualitative study, the food industry expressed concerns regarding potential decreases in sales, citing the belief that reducing salt content could adversely impact the taste of food and consequently affect sales (Gupta *et al*., 2018). Additionally, the prevailing lack of awareness among consumers regarding the amount of daily salt they intake and its associated health implications contributes to the perception that low-sodium food is bland and unappetizing (Michael *et al*., 2021).

The increase in costs is also one of the challenges expressed by the manufacturers. This concern was supported by a study estimating that reducing sodium levels by 20% to 30% could lead to a 5% to 30% increase in food costs, varying depending on the type of food products (Dötsch *et al*., 2009). Furthermore, alternative salts such as potassium chloride are more expensive and less common in Malaysia compared to developed countries (Yin *et al*., 2021). To overcome these challenges, marketing strategies to increase sales, such as online marketing campaigns can be organized (Lockett, 2018), emphasizing the advantages and health benefits of the product.

Nevertheless, the manufacturers remain optimistic about the feasibility of reformulations provided that the original taste of *keropok lekor* is retained and the product is well-accepted by customers. According to a survey conducted in Malaysia, taste is the primary factor driving consumers to buy *keropok lekor* (Omar *et al*., 2011), given its status as one of Malaysia's traditional delicacies. A systematic review and meta-analysis on customer acceptance of low-salt products revealed that salt content could be reduced by nearly 70 percent in processed meat-based foods without significantly impacting customer acceptance (Carraro *et al*., 2012). Additionally, in products like sausage and ham, reductions from 2.2 to 1.7 percent and from 2.3 to 1.3 percent, respectively, did not compromise the taste (Aaslyng *et al*., 2014). These findings suggest that food can be reformulated without compromising its original flavor, either by using salt alternatives or by gradually reducing the salt content.

Another suggestion by the manufacturers to reduce salt content in *keropok lekor* involves launching

a campaign to raise consumer and food industry awareness regarding the issue and providing financial incentives to the manufacturers. In addition, the implementation of nutrition labels displaying sodium content on products can further contribute to increasing consumer awareness (Hasnah *et al*., 2020). Food preparation and marketing training courses for manufacturers can be instrumental in supporting product reformulation efforts (Harnack *et al*., 2017; Michael *et al*., 2021).

Limitations and strengths of the study

This study only estimates the sodium content present in *keropok lekor* based on the formulations and ingredients shared by the manufacturers. Future research should focus on determining the actual sodium content in *keropok lekor*, undertaking reformulation efforts, and conducting comprehensive assessments of customer perception and other quality evaluations, such as sensory, physicochemical, and microbial testing. Nevertheless, this study is the first to gather the views and suggestions from the representatives within the *keropok lekor* industry. Data from this study could be used by policymakers to strengthen the strategies to reduce salt intake among the population through food reformulation.

CONCLUSION

In conclusion, salt (sodium chloride) and seasonings such as MSG added during the manufacturing process are the main sources of sodium in *keropok lekor*. Overall, based on the five themes derived from the interview sessions, it is evident the majority of manufacturers are supportive of efforts to reduce salt in *keropok lekor* to address health concerns, particularly hypertension, in Malaysia. However, several challenges or barriers have been identified, including concerns regarding customer acceptance, decreased sales, lack of awareness, increased material costs, and negative perception of the taste of *keropok lekor* with reduced salt content. These challenges may be addressed by preserving the authentic flavor of *keropok lekor* to ensure consumer acceptability, seizing marketing opportunities, and facilitating access to low-sodium salt. Efforts to inform the public about the new formulation of *keropok lekor* and its associated health benefits should be intensified, alongside frequent promotional campaigns.

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ETHICAL STATEMENT

This study has been approved by the Universiti Kebangsaan Malaysia Research and Ethics Committee (MREC) with UKM approval number (JEP-2022-148).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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