ANALYSIS OF INDIGENOUS SOYBEAN BISCUIT (KARA'I) CONSUMPTION IN JIGAWA STATE, NIGERIA: THE ANTIDOTE FOR HEALTHY DIET

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Abstract

This study investigated the consumption patterns and determinants of Kara'i, a traditional soybean biscuit, in Jigawa State, Nigeria. A multi-stage sampling technique was employed to select 316 consumers. Data were collected using structured questionnaires and analysed using descriptive statistics and inferential statistical methods (multiple linear regression and Heckman models). The findings revealed that 65.4% of the consumers were male, and 47.9% had some form of formal education. Most consumers (66.03%) were married, with an average household size of 12 people and an annual income of ₦332,197. Consumer preference for Kara'i was primarily driven by its taste (19.98%), palatability (19.98%), and affordability (20.91%). However, knowledge of its health benefits was generally low. The Heckit model indicated that age (coefficient = 0.135, $p < 0.01$), marital status (coefficient = 0.421, $p < 0.1$), and occupation (coefficient = 0.155, $p < 0.08$) positively influenced Kara'i consumption. Conversely, household size (coefficient = -0.039, $p < 0.08$) and expenditure on the product (coefficient = -5.121, $p < 0.001$) negatively impacted consumption. Key constraints identified include limited production (WMS = 2.38), short shelf life (WMS = 2.36), and inadequate awareness (WMS = 2.24). To enhance Kara'i's acceptability and consumption, strategies such as improved processing techniques, enhanced product quality, and targeted awareness campaigns are recommended.

Keywords: Soybean, Indigenous biscuit, Consumption, Heckman model, Jigawa State

INTRODUCTION

Globally, soybean consumption accounts for a large portion of direct and indirect protein with rising demand for soy products being propelled largely by consumer interest in plant-based protein options (Fraanje & Garnett, 2020). In Nigeria, direct human consumption of soybeans is significant, especially among rural low-income groups that can hardly afford animal-based sources such as meat, fish and eggs (Ogutu et al., 2024). Jigawa State ranked foremost among soybean producing States in Nigeria with notable consumption of soy products especially a snack called "awara" (The Jigawa State Agricultural Policy, 2024). Nigeria's soybeans sector has the advantage of being a country that only allows the farming of non-genetically modified organisms which has a niche demand in the global market (Nigeria Export Promotion Council, NEPC, 2020).

Recent trends in public health awareness towards plant-based diets and a reduction in the consumption of animal proteins have elicited the desire in humans to seek healthy alternative food sources such as the formulation of meat-like analogues, and cookies or biscuits (Ogutu et al., 2024, Kalu, 2023). Soybean and its associated products are one of the dietary elements that pose no significant health risks (Huang et al., 2016).

A healthy diet refers to a pattern of food consumption with no negative consequences on health (Ridder et al., 2017). A lack of understanding of healthy eating is evident in the global transition from traditional to modern eating patterns, which includes the migration of conventional eating patterns from their originating culture to other civilisations and the introduction of new foods and eating behaviours. These shifts have been referred to as a nutrition transition, which refers to a shift away from meals high in complex carbs and fibre to more diversified diets rich in lipids, saturated fats, and sugar (Popkin et al., 2013).

Nigeria is endowed with a variety of nutritious natural food resources that, if correctly utilized, will dispel worries linked with the intake of foods that are deemed health dangers. One of these dietary resources is soybean (Glycine max (L.) Merrill), with which Nigeria is endowed with a comparative advantage in its production. The crop contains 40% high-quality protein, 20% edible vegetable oil, and a good balance of amino acids (Collombet, 2013). These qualities have given soybeans tremendous potential to improve the nutritional status and welfare of resource-poor people, particularly in a

developing country like Nigeria (Omoigui *et al.*, 2020). Soybean is generally considered a highly versatile grain that has about 365 applications in the formulation of both human foods and animal feeds and other industrial uses, ascribing soybeans as the richest in food value of all plant foods consumed in the world (Ndife et al., 2011).

Nutritionally, soybean can be used in the production of many products such as bread, cookies, biscuits, pasta, cakes, baklava, dumplings, cornet, noodles, pasty, tarhana, nuts, baby food, confectioneries, chocolate, halva, milk, yoghurt, cheese, ice cream, tomato paste, meat, coffee, special dietetic products, dry and cold ready food mixture among others (Güzeler & Yildirim, 2016). The soybean plant has been cultivated and used as a food supplement because of its high content of macro-nutrients, essential for the well-being of an individual. For instance, soybean curd is one kind of traditional snack with high-quality protein that can be easily digested and absorbed (Shuhong et al., 2013, Guan, 2009). Incorporating soybean curd into a Western diet could be an important means of preventing and/or treating many chronic diseases, such as cancer and cardiovascular diseases as supported by epidemiological studies (Xinghua, 2008).

Several researchers have defined alternative ratios for using soybeans in the preparation of various enriched confectioneries to combat malnutrition (Bolarinwa et al., 2016, Ndife et al., 2014). Incorporating soybeans into carbohydrate-rich staple crops in Nigeria has been shown to boost protein content. Furthermore, soybean eating has been shown to prevent a variety of ailments, including cancer, diabetes, and menopausal difficulties (Wang et al., 2020; Takahashi, 2019, Zhao et al., 2018). Soybean's ability to improve household nutritional status, increase incomes, and boost agricultural yield is undeniable (de Valenca et al., 2017).

One of the many ways to consume soybeans is the locally made curd, called "awara" by people in northern Nigeria. Soybean curd, also known as *awara*, is considered one of the greatest locally produced snack foods in the northern region of Nigeria. It is prepared in a variety of ways to accommodate customer preferences. *Awara* snack has a moisture content of 9.17% and is high in protein (30.58%), crude fat (24.60%), and carbohydrates (27.50%), according to a proximate composition study (Zheng et al., 2020; Yusuf & Ali, 2013). Because of these qualities, a sizable portion of the public accepts the items as light cheese snacks (Rizo & Baroni, 2018). *Awara* is still regarded as an intermediate product, since it can be processed further to create other goods, such as "*kara'i*," a dry soybean curd derivative made from slices. Cutting soybean curd (*Awara*) into the appropriate slices (shapes and sizes), drying them, and then frying them in hot vegetable oil yields the product (*kara'i*). As per Abdulkadir et al. (2020), fried *awara* is more nutritionally and therapeutically significant than air-dried and sun-dried due to its considerable macro-nutrient content. It is also vital for an individual's survival and well-being.

The study therefore aims to investigate the consumption patterns, nutritional value, and health implications of *Kara'i,* a traditional soybean-based snack, among residents of Jigawa State, Nigeria.

MATERIALS AND METHODS

The study was conducted in Jigawa State, Nigeria, located between latitudes 11.00° and 13.00° north and longitudes 8.00° and 10.15° east of the Greenwich Meridian (Comprehensive Development Framework, 2013). The state shares boundaries with Kano and Katsina States to the west, Bauchi State to the east, and Yobe State to the northeast. The northern axis of the state shares an international boundary with the Zinder region of the Republic of Niger. A sample for the study was drawn after a reconnaissance survey of consumers of soybean curds derivative, (*kara'i*) in the state. Four local government areas were identified, one per agricultural zone, and a multistage sampling procedure was employed to select 316 patrons of *kara'i* for the survey. Thus, Birin-Kudu (Birnin-Kudu zone), Ringim (Gumel zone), Mallam-Madori (Hadejia zone), and Babura (Kazaure zone) were purposively selected on account of their dominance in soybean processing and consumption. Further, three communities in each sampled LGA were selected based on the popularity of soy curd consumption. Lastly, a random selection of 316 consumers from a pool of 1499 consumers was made using the probability proportional to size (PPS) sampling technique (Yamane's formula for sample size selection and Bowley's proportion allocation formulae). Data was elicited with the aid of a questionnaire and analyzed using IBM Statistics 22 and Jamovi 2.4.11 version software.

Yamane's formula for determining sample size is expressed as: $n = \frac{N}{1+N(e^2)}$
n = Sample Size, N = Population of the study, e = Margin of error (5%).

Bowley's proportion allocation formula is expressed as: $n_i = n\frac{N_i}{N}$
where: n_i = Sample size for the ith stratum, n = Total sample size, N_i = Population for the ith stratum, N= Total population.
Data collected were analysed using descriptive statistics (frequency distribution, weighted mean scores) and the Heckman regression model.

Heckman model: Analysis of *kara'i* consumption was achieved using the Heckman (Heckit) model (Heckman, 1979). In modeling the level of *kara'i* consumption, consumers' knowledge of the perceived benefits of *kara'i* was on the decisions of (i) consuming the product and (ii) how often or how much of the product to consume. The advantage of the two-stage decision models is that the same set of explanatory variables may be included in the two equations with differential effects between the two decisions (Moon *et al.*, 2004). Heckit model has wide application in various food consumption behaviours studies (Lei *et al.*, 2021, Akinbode The observed binary outcome (Y_i^*) is given by the probit model as;

$$Y_i^{*Probit} = (Y > 0)$$

The dependent variable is observed only if j is observed in the selection equation. Thus;

$$Y_i^{Select} = Z_i\gamma_i + U_{2i} > 0$$

The outcome equation is only observed if

$$Y_i = \begin{cases} X_j\beta_i + U_{1j} \; if \; Y_i > 0 \\ X_j\beta_i + U_{1j} \; if \; Y_i \leq 0 \end{cases}$$

Where, Y_i^* and Y_i are unobserved latent continuous variables. Y_j^{Select} is the dependent variable for the selection model, depicting a consumer's decision to consume the product (0 = not consumed and 1 = consumed). X is an m vector of explanatory variables, which include different factors hypothesized to affect *kara'i* consumption.

For the outcome model, the level of consumption was measured on a seven-day frequency scale. The mean score was obtained and frequencies less than the mean score (4) = 0; frequency scores greater than or equal to 4 = 1

In general, X_i is assumed to be a subset of Z_i, which means that all factors predicting the main outcome of interest (Y_i^*) also, predict selection Y_i. U_{1i} and U_{2i} are normally distributed error terms with mean zero and variance one, and β is the primary parameter vector of interest (Koné et al., 2019).

Explicitly, the Heckit model is expressed thus;

$$Y_i^{Decission \, (0,1)} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \\ + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 \\ + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \mu_1$$

$$Y_i^{*Con. \, level \, (0,1)} = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 \\ + \gamma_4 X_4 + \gamma_5 X_5 + \gamma_6 X_6 + \gamma_1 X_7 \\ + \gamma_8 X_8 + \gamma_9 X_9 + \gamma_{10} X_{10} + \mu_2$$

Where;
Y_i = dichotomous dependent variable (0 = non-consumers and 1 = consumers), Y_i^* = dichotomous dependent variable for consumption frequency, $\beta_0 - \beta_{10}, \gamma_0 - \gamma_{10}$ = parameters to be estimated for the selection and outcome models, respectively. X_1 = age of the respondents (years), X_2 = Marital status (married = 1; otherwise = 0), X_3 = Educational attainment (None = 0, Primary = 1, Secondary = 2, Tertiary = 3), X_4 = Household size (number), X_5 = Annual income (Naira), X_6 = Cost of the product

(Naira), X_7 = Preference scores (sum total of responses), X_8 = Amount spent on the product (Naira), X_9 = Respondents' occupation (1 = farming; 0 = otherwise), X_{10} = Health benefits knowledge (yes = 1, no = 0), $\mu_1 \; and \; \mu_2$ = Error terms.

RESULTS AND DISCUSSION

Consumers' Preference of the Consumption of *Kara'i*: Consumers' preference for the traditionally produced soy biscuit as against the conventional biscuits was adjudged using several different constructs. Figure 1 shows that 20.91% of the patrons of the *kara'i* attested to the fact the product is cheap and affordable. Similarly, 19.98, 15.68, and 19.06% of consumers reported that the preference was borne out of its appealing taste, palatability and aroma, respectively. This result aligns with the submission of Fabiyi (2006) who averred that, improving the milling techniques enhances greatly the palatability and digestibility of soybean products. This implies that consumption of *kara'i* and other soy products can receive a wide range of acceptability if the products are made more appealing, physically and nutritionally. Also, the fact that soy products, including *kara'i* are cheap and affordable tends to increase its consumption. Additionally, 14.84% of the respondents indicated that their choice of consumption is attributed to the tremendous health benefits that are ascribed to soybean consumption in general. A small percentage (9.53%) alluded that their preference for the product is that it is a ready substitute for conventional "cookies". This distribution suggests that sustained awareness of soybean products' improvement is needed to help improve the acceptability of soy products (Oyewole & Oghenetejiri, 2019).

Traditional Cookies from Soybean: Results of the health benefits of consuming soybean products among respondents are presented in Table 1. Results showed that respondents were knowledgeable of the benefits of soybeans, not only for children but also for adults (WMS = 2.01), and that soybean has a solution to malnutrition in both adults and children

(WMS = 2.09). This result is in tandem with the finding of Fadairo et al. (2020) who reported high knowledge of the nutritional and health benefits that come with the consumption of soybeans among post-primary students in Oyo State, Nigeria. On the contrary, respondents' knowledge of other health benefits of soybean in the prevention of infant and child mortality (WMS = 1.68), and reduced occurrence of low birth weight among pregnant women (WMS = 1.63) were low in the study area. This result is validated by the finding of Oyegbami *et al.* (2020) and Fadairo et al. (2020) that the knowledge of the health benefits of soybeans for

pregnant women was rated low on the knowledge scale. In addition, the knowledge statements that "Soybean products could be used as animal protein substitute in human diets" (WMS = 1.91), "Soybean is as rich in protein as animal (meat) or protein" (WMS = 1.92), and "Micro-nutrient that is mostly deficient in other foods cannot be supplied by soybean" (WMS = 1.98) were least. This result agrees with the finding of Oyewole & Oghenetejiri (2019) that the awareness of the utilization of soybean products was low in this regard.
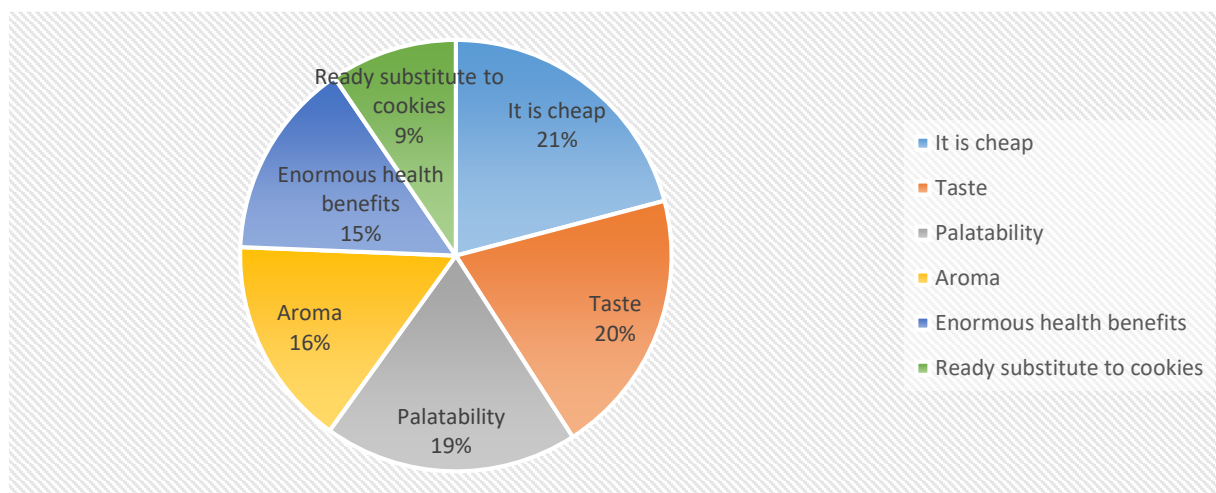

Figure 1: Consumers' preference of the consumption of Kara'i

Table 1: Awareness Level of the Health Benefits of *Kara'i* (n = 315)

Knowledge statement	Responses			MW	MWS*
	VH	M	L		
Soybean has solutions to malnutrition in both adults and children	132(396)	81(162)	102(102)	660	2.09
Soybean is not only good for children but also for the adults	101(303)	115(230)	99(99)	624	2.01
Micro-nutrients that are mostly deficient in other foods cannot be supplied by soybean	69(207)	172(344)	74(74)	625	1.98
Soybean is good for pregnant women	81(243)	142(284)	92(92)	619	1.96
Soybean is rich in protein as animal (meat)or protein	102(306)	86(172)	127(127)	605	1.92
Soybean products could be used as animal protein substitutes in human diets	78(234)	131(262)	106(106)	602	1.91
Soybean can prevent a massive number of infant and child death	65(195)	86(172)	164(164)	531	1.68
Soybean intake can reduce the occurrence of low birth weight among pregnant women	67(201)	165(230)	83(83)	514	1.63

*Cut off point = 2.00. <2.00 low and ≥2.00 High level of awareness. VH = Very high, M = moderate, L = low level of awareness. Source: Field Survey, 2023.

Determinants of *Kara'i* consumption: The result of a two-step decision modelling procedure (Heckit model) in Table 2 showed a highly significant Omnibus test (P<0.001), that measures the overall performance of the model. The non-

significant Omnibus Chi-square value in the Hosmer-Lemeshow test is proof that the data sufficiently fit the model. The Cox and Snell R^2 and Negelkerke R^2 (Pseudo R square statistics) suggested that between 9.6% and 13.40% of the

variability were explained by the set of variables included in the model. However, it is important to stress that the interpretation of the marginal influence of the predictors of *kara'i* consumption is based on the values of the coefficients of each predictive variable and the corresponding exponential values {Exp(β)}, the odds ratios (OR). According to Tabachnick and Fidell (2001), the odds ratio is the increase (or decrease if the ratio is less than one) in odds of being in one outcome category (high or low consumption level) when the value of the predictor increases by one unit. Further analysis showed that age of the respondents (0.135, p<0.009), marital status 90.421, p<0.097), main occupation (0.155, p<0.072) and cost of the product (*kara'i*) (0.065, p<0.055) were positive and significant factors that enhanced the consumption of *kara'i* in the study area. On the other hand, the amount spent on the product (-5.121, p<0.003), and household size (-

0.039, p<0.072) affect the degree of consumption negatively and significantly. The implication is that variables with positive coefficients tend to increase the probability of *kara'i* consumption whereas, independent variables with negative coefficients reduce the chances of consumers' tendency to consume the product.

For instance, the correlation of age and marital status with soybean consumption aligns with the submission of Tang et al. (2020), especially in the associated health benefits of soybean with age and a couple's reproductive improvement. The finding adds that women who drink soy milk one or more times per day are 56% less likely to develop osteoporosis than women who do not drink soy milk, which is comparable to 62% of the risk reduction of osteoporosis by drinking milk one or more times a day (Marjoribanks *et al.,* 2017).

Table 2: The Heckit model parameters for the *Kara'i* consumption

Variables	Coefficients	Std error	Wald	Sig.	Exp(B)
Age	0.135	0.052	6.754	0.009***	1.145
Marital status	0.421	0.254	2.756	0.097*	1.523
Educational status	0.108	0.100	1.182	0.277	1.114
Main occupation	0.155	0.086	3.237	0.072*	1.167
Preference scores	0.051	0.087	0.347	0.556	1.052
Cost of the product	0.065	0.034	3.695	0.055*	1.067
Amount spent on the product	-5.121	1.726	8.801	0.003***	0.006
Consumers' income	-0.108	0.233	0.216	0.642	0.897
Knowledge of health benefit	-1.517	0.978	2.409	0.121	0.219
Household size	-0.039	0.022	3.238	0.072*	0.962
Constant	14.123	4.615	9.364	0.002***	1.36e-06
-2 Log likelihood	364.247[a]				
Cox & Snell R Square	.096				
Nagelkerke R Square	.134				
Chi-square	32.326***				

***, and ** represent the levels of significance at 1, and 10% respectively
Source: Field Survey, 2023

Table 3: Distribution of Respondents based on Constraints to *kara'i* Consumption (n = 315)

Constraints	Major	Minor	No constraint	MW	MWS
High perishability of the product or short shelf life	141 (423)	116 (232)	58 (58)	713	2.26
Seasonal product	129 (387)	103 (206)	83 (83)	676	2.15
Low knowledge of the health benefits of the product	136 (408)	86 (172)	93 (93)	673	2.14
Lack of public awareness of the product	110 (330)	98 (196)	107 (107)	633	2.01
High cost of the product	83 (249)	107 (214)	125 (125)	588	1.87
Low household acceptance	64 (192)	138 (276)	113 (113)	581	1.84
Others (taboo, low acceptability)	43 (129)	76 (152)	196 (196)	477	1.51

Source: Field Survey, 2022: N = number, MW = mean weight, WMS = weight mean score.
*Threshold = 2.00. <2.00 no/less and ≥2.00 major constraint.

Constraints to the consumption of *kara'i*: The catalogue of constraints affecting the consumption of soybean product (*kara'i*) in Table 3 showed that high perishability/short shelf life (WMS = 2.26),

seasonality of the product (WMS = 2.15), low knowledge of the health benefits of soybean products (WMS = 2.14) and lack of public awareness of the product (WMS = 2.01) were the

prime constraints militating against the consumption of the indigenous biscuit in the study area. This finding agrees with Oyewole & Oghenetejiri (2019) who identified short post-processing shelf life, low household acceptance and inadequate processing skills as constraints affecting the utilization of soybean products. Also, Kamara et al. (2018) reported that the processing and utilization of soybeans is constrained largely by a lack of awareness of processing, and utilization methods, and limited availability of processing equipment.

Conclusion and Recommendations

Kara'i is a popular and affordable snack, valued for its taste, palatability, and perceived health benefits. However, challenges such as short shelf life and limited awareness hinder its wider consumption.

The study thus recommends that;

1. Invest in research and development to improve *Kara'i's* processing techniques, packaging, and storage methods to extend its shelf life and maintain its quality.
2. Conduct awareness campaigns to educate consumers about the nutritional benefits of *Kara'i* and dispel misconceptions about soybean products.
3. Provide financial and technical assistance to small-scale producers to improve their production capacity, quality control, and market access.
4. Advocate for supportive policies that incentivize the production and consumption of *Kara'i*, such as tax breaks, subsidies, and favorable regulations.

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