AWARENESS AND CONSUMPTION PATTERNS FOR PRECOOKED BEAN PRODUCTS AMONG HOUSEHOLDS IN MACHAKOS COUNTY, KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfillment of the Requirements for the Master of Science Degree in Agricultural and Applied Economics of Egerton University

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has never been submitted in any academic institution for the award of any degree certificate.

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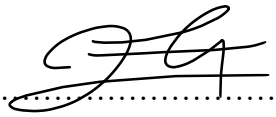
Recommendation

This thesis has been submitted with our approval as Egerton University supervisors.

Signature……  Date 23/02/24

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DEDICATION

I dedicate this work to my parents (Mr. & Mrs. Mutegi Njau), son (Ethan Githaiga) and siblings for their love, emotional support, and understanding throughout the process.

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ABSTRACT

Beans are a good source of protein, fibre, complex carbohydrates, and micronutrients. Their consumption is however limited by the high energy and water requirements for cooking as well as the long cooking time. As a result, precooked bean products which require less cooking time, fuel, and water, were introduced in Kenya, to increase bean consumption, improve nutrition and conserve the environment. Despite this intervention, there is still insufficient consumption of precooked bean products, which has been attributed to inadequate information about the products. This study, therefore, sought to assess consumer awareness and consumption patterns for precooked bean products. The specific objectives of this study were to determine consumer awareness, factors influencing consumer preference and consumption frequency for precooked bean products among households in Machakos County. A multistage sampling technique was used to select a sample size of 385 respondents and a semi-structured questionnaire was used for data collection. Descriptive statistics, Multivariate Probit and Poisson regression models were used for analysis using STATA computer software. Findings indicate that majority (52%) of the respondents are aware of precooked bean products. In addition, consumer preference for precooked bean products is significantly influenced by gender, household size, presence of a child below five years, employment, monthly income, health status of a household, market distance, cooking time, fuel, colour and shelf life. Further, the findings reveal that consumption frequency for precooked bean products is driven by age, education, presence of a child below five years in the household and nutrition knowledge. However, employment, household size and colour of these bean products negatively affects consumption frequency. This study concludes that the nutrition content of precooked bean products significantly influences their consumption patterns. Thus, this study recommends that policymakers and other stakeholders should emphasize the nutrition and health benefits of precooked bean products when making policy decisions and strategies. This could promote consumption of precooked bean products as well as enhance household food and nutrition security. Emphasizing the economic benefits of consuming precooked bean products could equally be important in enhancing consumption and conserving the environment.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AERC	African Economic Research Consortium
CIAT	Centre for International and Tropical Agriculture
DHM	Double Hurdle Model
FAO	Food and Agriculture Organization of the United Nations
GAIN	Global Alliance for Improved Nutrition
GOK	Government of Kenya
IDRC	International Development Research Center
KALRO	Kenya Agriculture and Livestock Research Organization
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KMs	Kilometers
KNBS	Kenya National Bureau of Statistics
KSHS	Kenya shillings
LDL	Low-Density Lipoprotein
LR	Likelihood Ratio
MoALF	Ministry of Agriculture, Livestock and Fisheries
MT	Metric tonnes
MVP	Multivariate Probit
NBR	Negative Binomial Regression
NCPD	National Council for Population and Development
NGOs	Non-Governmental Organizations
OLS	Ordinary Least Squares
PCB	Precooked Bean
PEM	Protein Energy Malnutrition
RUM	Random Utility Model
SDG	Sustainable Development Goal
ZINB	Zero Inflated Negative Binomial
ZIP	Zero Inflated Poisson

CHAPTER ONE
INTRODUCTION

1.1 Background of the information

Beans represent the most important grain legume for direct human consumption. They are highly nutritious foods containing protein, fibre, complex carbohydrates and micronutrients (Rezende *et al*., 2017). This source of protein is cheaper compared to animal-based protein thus making it important in the diets of poor people in Africa (Ferreira *et al.*, 2021). According to Mullins and Arjmandi (2021), beans have been associated with prevention and management of chronic diseases such as heart disease, stroke, fatty liver, obesity, chronic respiratory diseases, and diabetes. In Kenya, beans account for 9% of staple food calories and 5% of total food calories in diets, hence their importance to national food and nutrition security. Beans play a role in reducing food insecurity, hunger, and malnutrition, especially for the poor. They are largely grown by women for subsistence and about 40% of the production is marketed at a value of USD 452 million (Mangole *et al.*,2022). They are produced across the world with the major production being from Asia and Latin America (Sousa, 2019). The largest quantity of dry beans is produced by developed countries which have become less dependent on agricultural exports (Rezende *et al.*, 2017). In 2019, the leading exporting countries of dry beans were Myanmar, Argentina and the United States while the leading importing countries were India, Brazil and Turkey (FAO, 2017). In the same year, Kenya imported 75,830 tonnes of dry beans, making it among the top twenty countries in the world to import dry beans.

According to Duku *et al*. (2020) annual national consumption of beans in Kenya is approximately 755,000 MT, whereas per capita consumption is about 14 kg per year. In the western parts of the country, per capita consumption can go as high as 66 kg per year. Dry beans are mainly consumed in the local dish known as *githeri*, which is a mixture of maize and beans. However, studies by Aseete *et al*. (2018) and Mukamugema *et al*. (2019) show that consumption of dry beans has been constrained by long cooking time, high energy and water requirements. As a result, in 2014, precooked bean (PCB) products were introduced in Kenya by the Centre for International and Tropical Agriculture (CIAT) in collaboration with Kenya Agriculture and Livestock Research Organization (KALRO) through a project called 'PCB for improving food and nutrition security'. The PCB products were introduced to improve food and nutrition, income generation and conserve

natural resources. Two factories for processing PCB products were established in Kisumu and Machakos counties for commercial production. The factories supply these products to institutional consumers such as supermarkets, hotels, schools, and hospitals, and individual consumers around the counties.

The PCB products are produced from selected dry bean varieties which are from red mottled sugar and yellow bean families. These varieties were selected for production and industrial precooking based on their cooking time, colour, micronutrient content and ease of growing. The selected dry bean grains undergo hydration, cooking and sterilization, and dehydration to produce packed PCBs. The PCB grain is further processed to produce three other products: bean flour, bean noodles and bean snack. The packed PCBs can be used to prepare soups and make pasta dishes and the bean flour is used to make porridge, thicken soups and sauces, or can be blended with other flours. The PCB products are reheated 5-15 minutes before they are consumed thus requiring less time, water, fuel and labour (Aseete *et al*., 2018). They are convenient for households as they are more affordable than other types of processed beans such as frozen and canned beans (Mukamugema *et al*., 2019).

The PCB project carried out an *ex-ante* analysis of the potential demand for the products. The analysis showed that PCB products have potentially high demand due to the rapid expansion of urban populations, rising incomes among the middle-income population and high fuel costs. An ex-ante analysis by Aseete *et al*. (2018) revealed that PCB products would be readily accepted by consumers with acceptance levels of up to 89.1%. The analysis further revealed that there were three segments of bean consumers: PCB products enthusiasts, conservative self-reliant bean consumers and nutrition enhancement lovers. The PCB products enthusiasts had the smallest household size, reported the highest expenses for preparing a meal of beans and faced the furthest distance to the nearest bean market and water sources.

To promote the consumption of PCB products, materials such as leaflets, brochures, product panels, branding materials and fliers on these products were developed and models for both formal and informal uptake were tested (Ugen *et al*., 2017). The marketing strategy was however not fully achieved because the promotional materials were tied to the availability of PCB products. More so, most potential consumers of these products had not been sensitized on the product's availability and attributes. According to Mukamugema *et al*. (2019), the use of PCB products is constrained by a lack of sufficient consumer knowledge of the products, as well as its

limited supply to the market. The study findings further revealed that 71.9 percent of consumers perceive PCB products as unavailable in the market. The perception result of this study suggests that a lack of sufficient product information hinders the consumption of PCB products. Moreover, empirical studies on consumer knowledge and preference for PCB products have not been adequately established. Therefore, to bridge this knowledge gap as well as promote the consumption of PCB products, there is a need to provide information on consumer awareness, preference, and consumption frequency for PCB products.

1.2 Statement of the problem

The PCB products have a reduced cooking time and long shelf-life, thus proving to be convenient, especially to the current generation that prefers fast food and women in careers. Beans are cheaper protein sources compared to animal-based protein making them important in diets of low-income households, whose composition of the food basket is slightly skewed towards cereals, which have low protein content. In addition, dietary fibre in beans helps in lowering total blood cholesterol levels; therefore, consumption of PCB products improves diet quality and reduces health risks associated with consumption of animal protein. Thus, government and non-governmental organizations have been at the forefront in promoting consumption of PCB products. Despite these efforts, there is still insufficient consumption of PCB products. Few studies which have been done on these products were majorly ex-ante and included research on potential demand, willingness to pay and adoption of PCB products. However, information regarding consumer awareness, preference and consumption frequency for PCB products is not readily available. This study sought to bridge this knowledge gap through an exploratory study on the awareness and consumption patterns for PCB products among households in Machakos County. Results from this study will help in enhancing consumption of PCB products thereby improving households' nutrition status.

1.3 Research objectives

1.3.1 General objective

To contribute to household food and nutrition security through analysis of awareness and consumption patterns for PCB products among households in Machakos County, Kenya.

1.3.2 Specific objectives

i. To determine consumer awareness of PCB products in Machakos County.
ii. To determine factors influencing consumer preference for PCB products in Machakos County.
iii. To determine factors influencing consumption frequency for PCB products among households in Machakos County.

1.4 Research questions

i. What is the level of consumer awareness of PCB products in Machakos County?
ii. What factors influence consumer preference for PCB products in Machakos County?
iii. What factors influence consumption frequency for PCB products among households in Machakos County?

1.5 Justification of the study

With rising incomes among the middle-income population, rapid expansion of the urban population and more women in careers, PCB products are convenient to households since they require less cooking time, fuel, and water. Focusing on Machakos county which has a growing urban population, this study sought to establish consumer knowledge, preference, and consumption frequency for PCB products. Information from this study provides insights to households on the importance of incorporating PCB products in their meals to achieve a balanced and protein-rich diet. Additionally, PCB products are sustainable and resilient in that they can reduce food waste by extending the shelf life of beans and enhancing their utilization. They can also contribute to food security by providing a reliable and stable source of protein during times of crisis, such as drought, conflict, or pandemic. Thus, this study contributes to the second Sustainable Development Goal (SDG), which advocates for eradicating hunger, attaining food security and improved nutrition, and advancing sustainable agriculture. Further, the study contributes to the food and nutrition security policy of Kenya which advocates for an increase in the amount and quality of food that is always available, affordable, and accessible to all Kenyans to maintain optimal health for all its citizens. From this study, it is expected that consumption of PCB products will rise, resulting in a healthier population.

1.6 Scope and limitation

This study was conducted in Machakos town sub county, Kenya. The study examined PCB products (Appendix G), that were introduced in Kenya by KALRO and CIAT and whose consumption among Kenyan consumers is being promoted by these organizations. It focused on households that purchased PCB products in 2020. The PCB products studied were packed beans, bean flour, bean noodles and bean snack. To determine consumer awareness, this study involved both consumers and non-consumers of PCB products. Additionally, it relied on recall information provided by the respondents due to inadequate purchasing records by households. To overcome this challenge, probing was carried out to capture quality information during data collection.

1.7 Operational definition of terms

Consumption- this is the use of PCB products by households.

Consumer awareness- this is when consumers have information about PCB products in terms of their quality.

Consumption frequency- this refers to the number of times a household consumed PCB products in each month.

Consumption patterns- this describes how households purchase and consume PCB products in each period.

Consumer preference- this is the household's tendency to like or favour PCB products over other bean products in the market.

Dry beans- these are beans that have been preserved for future use through drying.

Food and nutrition security- Physical, social, and economic access to sufficient, safe and nutritious food which meets dietary and food preference needs.

PCB- these are beans processed by cooking under high temperatures and pressure and packed in air-tight and weather-proof sachets that can preserve them for over six months.

PCB consumer- this is a household or individual who purchases PCB products for direct use.

PCB products- these are bean products produced from precooked bean grains.

CHAPTER TWO
LITERATURE REVIEW

2.1 Food and nutrition security

Food and nutrition security refers to a situation where all individuals at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for a productive and healthy life (Peng & Berry, 2018). Nutrition security refers to adequate nutritional status in terms of protein, energy, vitamin, and minerals for all household members at all times (Bilali *et al*., 2018). Therefore, nutrition security nutrition is a broader concept than food security, as it considers not only the availability of food but also its nutritional value and the factors that influence an individual's nutrition status. Moreover, nutrition is the process by which individuals utilize food substances, and nutrition status is the state of health, determined by food intake. Nutrients are important for energy provision and maintenance of vital processes such as digestion, breathing, growth, and development. Protein is of importance in the production and repair of tissues in the body.

Malnutrition is a significant contributor to reduced economic productivity, poor health, poor school performance and reduced work capacity (Siddiqui *et al*., 2020). Chronic and acute malnutrition and micronutrient deficiencies are prevalent, particularly among the rural populations and urban poor. The most pressing form of malnutrition in Kenya is protein-energy malnutrition (PEM) which is caused by a deficiency of energy, dietary protein, and micronutrients. PEM manifests as low body weight, stunting, acute weight loss, or edematous malnutrition (Kwashiorkor) (Ahmed *et al*., 2020). It hinders physical growth and intellectual development affecting the future national labour force and individual work capacity. Foods recommended to aid in the treatment of PEM are starchy foods, fruits and vegetables, and animal and plant proteins such as beans. The high burden of malnutrition in the country is a clear indication of the inadequate realization of human rights. The right to food includes not only a sufficient number of calories but also the right to nutritious foods that guarantee health, growth and development throughout a person's life cycle. With proper nutrition, poverty and hunger are eradicated, mental capacity and maternal health are improved, and child mortality and diet-related diseases are reduced.

Enhancing food and nutrition security in a country improves health and productivity and contributes to social wellbeing and economic development (Raposo *et al*., 2022). The 2030

development agenda states that all nations need to take action to combat hunger, attain food security, enhance nutrition, and advance sustainable agriculture. An estimated 821 million people worldwide are undernourished (FAO, 2017), which is an unacceptable high figure. According to the National Council for Population Development (NCPD) (2019), the situation is likely to get worse, given the expected increase in global population to 9.7 billion people by 2050, current and emerging food supply constraints, shifting consumption patterns, and the anticipated effects of climate change. According to the 2017 food security act and the constitution of Kenya, food security and nutrition are one of every person's fundamental human rights. As a result, the government has duties to uphold, safeguard, and ensure food and nutrition security.

The Kenyan government seeks to lower food insecurity among Kenyans by 50 percent, the level of malnourished children under the age of five by 27 percent, and the expense of food as a percentage of income by 47 percent (NCPD, 2019). To achieve this, the government should deal with obstacles of ending hunger to achieve food security and appropriate nutrition. According to the Kenya Institute for Public Policy and Analysis (KIPPRA) (2017), the nation has been experiencing a shortage of all food categories due to low output and post-harvest losses brought on by poor storage. The two major obstacles to improved food and nutrition security, especially in developing nations, are increased population and rapid urbanization.

The Kenya Household and Budget Survey from 2015 to 2016 indicates that there are 84 dependents for every 100 workers in Kenya. Due to a lower percentage of the people being employed, the high age-dependency ratio reduces agricultural productivity. Additionally, according to National Council for population and Development (NCPD) (2019), the percentage of Kenyans residing in urban areas increased from 31.1 percent of the total population, or about 5 million people, in 1999 to 12 million people in 2009, having a significant impact on food security and nutrition. Thus, the Government of Kenya (GoK) places nutrition central to human development and is working with ministries and external organizations to improve nutrition in the country. In addition, GoK approved a national nutrition action plan in 2012 that focuses on the use of research to influence food and nutrition security policy and practice. It is in the ‘big four priorities’ of the government to achieve zero hunger and improve nutrition in the country.

2.2 Nutrition and health benefits of beans

Beans are considered a cheap source of nutrients and are recognized as a poor man's meat (Semba *et al.*, 2021). They are considered to be one of the best means of alleviating food insecurity and malnutrition in developing countries (Mukamugema *et al*., 2019). They are a good source of proteins, which are 2-3 times that of cereal grains. Beans are also rich in complex carbohydrates, which have most calories in the form of starch, resistant starch, and little amounts of non-starch polysaccharides.

Regular bean intake has proved to be good for obese individuals by lowering total serum cholesterol and low-density lipoprotein (Ganesan & Xu, 2017). Beans have been found to have anti-obesogenic activity by reducing the regulatory enzymes involved in fatty acids and cholesterol biosynthesis (Añazco *et al*., 2023). A study by Tucker (2023) found that bean consumers had a lower body weight, a smaller waist size and lower systolic blood pressure compared to non-consumers. This was attributed to the high fibre and protein content of beans which contribute to feelings of fullness and satiety. Further, results revealed that bean consumers had higher intakes of dietary fibre, potassium, magnesium, iron, and copper relative to non-consumers.

Consumption of beans has also been associated with a reduced risk of cardiovascular disease by reducing inflammation (Ganesan & Xu, 2017; Winham *et al*., 2016). According to Vieira *et al*. (2023) bean intake was associated with a reduced risk of cardiovascular disease. Their high fibre and potassium content increase bile acid excretion which leads to a decrease in LDL cholesterol which contributes to heart disease. In addition, the consumption of canned and cooked beans has been shown to improve serum lipid profiles in patients with coronary heart disease. Doma *et al.* (2021) reported that one serving (180 g) per day of beans was associated with a lower risk of heart attack, while more than one serving per day did not provide any further decreased risk.

Bean intake has also been associated with decreased risk of breast, stomach, colorectal, kidney and prostate cancers (Patel *et al*., 2023). Bigman *et al.* (2022) found that bean and lentil intake have a significant inverse association with the risk of breast cancer. According to Ganesan and Xu, (2017) consuming beans two or more times per week decreased the risks of colon cancer by 47%, breast cancer by 67% and prostate cancer by 22%.

2.3 Consumer awareness of food products

Consumer awareness is an act of making sure households have information about products, services and consumer rights (Nayanshi, 2023). It is the ability of consumers to recognize or recall a product brand. Informed consumers are aware of their rights and responsibilities and protect themselves from exploitation which is rampant in the food industry. Achola *et al*. (2020) reported a significant relationship between awareness and consumer behaviour. They found that awareness leads to effective consumers behaviour while unawareness leads to decreased individual capacity in protecting and upholding consumer rights from exploitation. Consumer awareness establishes a healthy economic environment where consumers are protected, and businesses are accountable to their customers. Awareness is thus an asset to individuals and society as it enhances individual critical thinking and life skills and promotes satisfaction by creating realistic expectations that enhance economic stability.

Media plays an important role in improving the awareness of individuals or society. Siddiqui *et al*. (2022) found newspapers, television, and radio as important sources of information about genetically modified foods. The study found that newspapers and television were important information sources for high income and more educated consumers. Likewise, Pambo *et al*. (2014) found radio, television and newspaper as important sources for disseminating nutrition information of fortified sugar. Further, the study found that the use of media was more effective in rural areas, whereas in urban areas use of internet options, mobile phones and displays at the supermarket would be more effective. Heo and Kim (2019) confirmed that broadcasting media (television and radio) and online platforms provide considerable information on processed foods.

Consumers also draw knowledge such as food quality, nutrition content and food safety from food labels. Jain *et al*. (2018) indicate that most consumers prefer food items with labels. However, only 76% of the participants check food labels every time during purchase and only 7.2% understand the food label. This suggests that a low percentage of consumers reading food labels regularly. Roseman *et al*. (2017) indicate that when nutrition information is presented on restaurant menus and packaged food labels, consumers develop a favourable attitude towards the product and purchase intention. However, Darkwa, (2014) indicates that awareness and knowledge of food labelling may not always adequately impact food choices.

Hettiarachchi *et al*. (2019) employed descriptive statistics to examine consumer awareness and perception on highly processed foods in Sri Lanka among 500 randomly selected respondents

from all over the country. The study findings indicated that majority of respondents (74%) were aware of the highly processed foods available in the country with the highest level of awareness being observed in Kalutara and Colombo districts. Additionally, younger respondents were found to be more aware of the highly processed foods compared to their older counterparts. Likewise, Tas *et al*. (2015) surveyed 1,315 people in Turkey about their awareness towards genetically modified food consumption. The survey's findings revealed that, while consumers usually understand what genetically modified organisms are, they lack sufficient knowledge of the genetic modification procedure. These results support those of Popek and Halagarda (2017) who revealed that almost half of the respondents in the selected European countries were aware of the genetically modified organisms' concept. Similarly, the present study adopted descriptive analysis to examine the level of consumer awareness on PCB products among 385 respondents in Machakos County, Kenya.

Lutomia *et al*. (2021) examined consumer awareness of PCB snack among 249 rural consumers in Machakos County, Kenya. Results from descriptive analysis revealed that only 21% of respondents knew about the processed bean products that were readily available. The low level of awareness was expected because the product was new, there had been inadequate consumer education that had been done, as well as the fact that these products had not yet entered the rural markets. However, the study, examined awareness on only one PCB product. To overcome this challenge, the present study examined the level of awareness on all the four PCB products available in the market.

2.4 Factors influencing consumer awareness of food products

Kirui (2020) evaluated awareness of baobab products among 353 consumers in rural and urban townships in Kenya. Results from the study revealed a low level of awareness of baobab products in both urban and rural townships. Zero truncated regression results showed that age, gender, income, and group membership significantly influenced awareness of baobab products in urban areas whereas age and education level significantly influenced awareness level in rural parts. Results from this study corroborated with those of Ibitoye *et al*. (2014) who found age, gender, education level, and income level to have a significant influence on the awareness of organic rice in Malaysia. Further, the study revealed that female consumers were more aware than their male counterparts.

Pambo *et al*. (2014) assessed factors influencing consumer awareness of fortified sugar among 350 consumers in Nairobi and Kakamega, Kenya. Results from logistic regression revealed that the age of consumers, purchasing from supermarket, reading a newspaper, living in urban areas as well as having a child below the age of five years were the significant factors influencing consumers' awareness while marital status and years of formal education had insignificant effect of awareness on fortified sugar. The use of the Logistic regression model is limited in that it does not assume normality, linearity, and homogeneity of variance for explanatory variables. To overcome this challenge, Charity (2016) employed a Probit model to examine factors influencing geographical indication awareness of honey consumers in the urban areas of Kenya. Results showed that education level, trust, gender, consumers' perceptions, income, and information influence awareness significantly at 1% confidence interval. Kilic and Eryılmaz (2015) also employed a Probit model to determine factors affecting the food safety awareness of 384 consumers in the urban areas of Samsun province in Turkey. The results indicated that socio-economic variables (gender, education, and income) and behavioural variables (consumption of organic food and consumption of low-priced genetically modified food) had considerable effects on consumers' awareness of food safety.

Pushpa *et al*. (2021) examined consumer awareness towards organic food among a sample of 600 consumers selected from six urban districts in Sri Lanka. Descriptive analysis revealed that there was a good level of awareness on organic foods by the consumers. Additionally, results from multiple linear regression analysis revealed that socio demographic factors such as monthly income, gender, education, and marital status significantly affect consumer awareness. Likewise, Chirilli *et al*. (2022) examined socio demographic characteristics that could influence awareness of consumers on packaging of foods for environmental sustainability among 646 online respondents. The study carried out an analysis of variance and t-tests. The findings indicated that gender, age and level of education were key variables influencing consumer awareness. Further, Simmaky *et al*. (2015) evaluated consumer awareness of food labels among 260 respondents who bought pre-packaged foods from supermarkets and retail stores in Jaffna region. According to descriptive findings, 92% of respondents are aware of the information on food labels. Level of income, age, occupation, and schooling of respondents were all significantly associated with awareness of and use of information on food labels. Muhammad *et al*. (2016) introduced another variable, nationality, in the analysis of socio demographic factors that could influence consumer's

awareness towards organic food products in the United Arab Emirates. Results from ordinary least squares regression revealed that nationality was a significant factor along with gender, occupation, age, income as well as education.

2.5 Consumer preference for food products

Consumer preference is an individual's habit of liking or favouring a product over other alternatives. It is an individual taste that is measured by the utility of various bundles of goods. It can be seen as an individual's predisposition in selecting goods that they perceive as enjoyable. When valuing different products and services together with their attributes, it is important to understand consumer preferences, behaviours and attitudes to effectively address consumer needs. Consumer preference, therefore, is a standard for assessing service and determining the level of consumer satisfaction (Dolšak *et al*., 2020).

Consumer preferences are heterogeneous. Understanding preference heterogeneity can improve consumer satisfaction through customized services. Dolšak *et al*. (2020) found heterogeneity in residential consumer preferences for electricity supplier offers. Aseete *et al*. (2018) found significant heterogeneity in consumer valuation and preference for PCB attributes. Preference heterogeneity is brought about by the demographic characteristics of consumers, consumer behaviour toward a product, their attitudes and habits, and their environmental values and knowledge about the product. Aseete *et al*. (2018) note that heterogeneity in PCB attributes is explained by sex and education of the respondents, volumes of beans consumed, location and sufficiency in their own bean supply. Consumers may reveal their preferences through their actions or state their preferences if a product does not exist in the market (Charity, 2016). A revealed preference technique depends on observations of real market behaviour to elicit consumer preferences and includes travel cost and hedonic pricing method. A stated preference technique relies on individuals to state their preferences in a hypothetical setting and includes conjoint analysis, contingent valuation method and choice experiment.

2.6 Factors influencing consumer preference for food products

Consumer preference for food is influenced by several factors which have been categorized into six components that include economic, psychological, personal, social and cultural, and product-related factors (Teweldemedhin & Mulonda, 2016). Socio-economic factors

include age, sex, education level, health status, income and time constraints (Ahmed *et al*., 2020). Factors that are product-related such as taste, colour, price and information obtained from its label differ from product to product, thereby producing different perceptions and consumer behaviour.

Byarugaba *et al*. (2020) adopted a partial least squares regression to evaluate consumer preference for bean sauces based on their sensory attributes among 120 consumers. The results showed that bean sauces were more distinguishable by appearance, taste, and mouthfeel than by aroma, flavour and after-taste. Further, consumer preference was significantly ($p<0.05$) positively influenced by brown colour and negatively by lumpiness which was both sensory descriptors of the appearance of sauce. Likewise, Atilola (2018) assessed consumer preference for purple, mixed yellow and yellow beans among 900 households in Lusaka, Zambia. The Logit regression results revealed that gravy quality, cooking time and price were important bean attributes influencing consumer preference while grain size had no statistically significant effect. Further, the study found that gender, education and employment status of the household head, as well as the household's child dependency ratio, dual household income, residential area and perception of the bean food group's role in nutritional security, were statistically significant in their effect on preference for purple, mixed yellow and yellow beans. These findings were consistent with those of Swema and Mwinuka (2021) who found the cooking time of beans as one of the major driving factors of consumer preference for beans in the market. Although these studies have done consumer preference of various beans and bean products in the market, they have captured the sensory and physical attributes of these products. However, most authors have not considered that not only the sensory and physical attribute, but also, the amount of fuel and water used in cooking these products may influence consumer preference. Therefore, this study used a multivariate Probit and captured amount of water and fuel used as variables to estimate the likelihood of consumer preference for PCB products.

Likewise, Bidar and Farkhari (2022) examined the factors influencing consumer preference for ready to eat foods among 90 consumers in Kabul city. Descriptive statics results revealed that less than half of the respondents preferred the ready-to-eat products. From the Garett's score, taste, convenience, easy availability, and quality were the key factors found to influence preference for ready to eat foods. However, this study left out the socio-economic characteristics of the respondents which could be some of the contributing factors affecting preference. In addition, the study employed descriptive statistics. The current study used a bigger sample size of 385

respondents and included the socio-economic characteristics of households to examine consumer preference for PCB products. Further, the present study employed a Multivariate Probit (MVP) model to examine factors influencing preference for these bean products.

Teweldemedhin and Mulonda (2016) examined factors related to general household characteristics and their influence on consumer preferences for sweet potatoes among 353 respondents in the areas of the Windhoek district in Namibia. Results from logistic regression showed that the age and employment status of the household head were negative and significant and had a bigger weight, implying that an increase in these variables would lead to a small consumption of sweet potatoes. Further, the gender of the respondent was found to be positive and significant while education level was not significant. These results were contrary to those of Bahety *et al*. (2022) who found education level to be one of the social demographic factors which were significant in influencing consumer preference for milk and its' products followed by factors such as price, quality, health consciousness and availability by Indian consumers.

Likewise, Hagan and Vitor (2020) examined the determinants of consumption of imported rice among 327 consumers in Kumasi Metropolis in the Ashanti region of Ghana. Probit regression results revealed that age, household size, income, education, and gender were statistically significant. In addition, education, gender, and income, influenced the consumption of imported rice positively while, household size, age and price had a negative influence on the consumption of imported rice. These findings were consistent with those of Kilima and Bolle (2020) who employed the Craggs Double Hurdle Model (DHM) and found that expenditure on selected bean varieties was significantly influenced by the income status of consumers and education among other factors. However, these studies did not consider health status of the household and therefore, this study filled this gap by introducing health status variable to explain consumer preferences for selected PCB products.

Rahman and Islam (2020) used a semi-structured questionnaire to survey consumption preference of fish among 128 respondents from Rangpur city corporation, Bangladesh. The study findings indicated that there was a significant positive association between consumption and income, education as well as the profession of an individual. Likewise, the current study investigated the relationship between socio economic factors and consumer preference for PCB products among consumers in Machakos county.

Nuani *et al*. (2022) adopted an MVP model to investigate consumer preference for roots and tubers among 385 respondents in Nakuru County, Kenya. The study results indicated that preparation time, Covid-19 pandemic, production location, availability, cultural orientation, nutritional knowledge, retail prices, farming of roots and tubers, taste, size, quality, education and monthly income influence preferences for the selected roots and tubers. However, the result of this study shows a positive relationship between market distance and consumer preference for roots and tubers in urban households. The present study anticipates a significant negative relationship between distance from home to the nearest market and consumer preference for PCB products. Thus, the present study also employed MVP model to determine the relationship between market distance and consumer preference for PCB products in Machakos County.

Meng *et al.* (2019) examined consumer preferences for the various groundnut products by investigating the socio economic and demographic factors among 1076 urban residents in Ghana. The findings of the bivariate ordered regression analysis showed that preferences for roasted groundnuts were significantly influenced by factors like taste, protein content, and healthfulness, whereas preferences for groundnut paste were significantly influenced by factors like aroma, taste, and protein content. Socio economic characteristics such as household size and education had significant effects on roasted groundnuts and paste. Additionally, the presence of a child between the age of 4 and 12 positively and significantly influenced preference for roasted groundnuts. Similarly, the present study investigated consumer preference for selected PCB products. However, the present study employed MVP in the analysis of preference.

Ndenga *et al*. (2017) analyzed consumer preference in product attributes of indigenous chicken eggs in Nairobi and Makueni counties in Kenya among 180 respondents. The study findings revealed that size, colour, and shape were factors found to be attributes that influence preference. This study examined the product related factors and did not factor in factors such socioeconomic characteristics of respondents. Therefore, the present study included the socioeconomic characteristics, market factors and product related factors to determine consumer preference for PCB products.

2.7 Consumption frequency for food products

Frequency of consumption refers to the number of times a product is consumed in a given period. Winham *et al*. (2019) adopted descriptive statistics to determine consumption frequency

for dry and canned beans among 158 women aged 18-65 years. The results showed that 15.2% of the respondents did not buy any beans, 18.4% only bought dry beans, 16.55% only bought canned beans and 50% bought both dry and canned beans (p=0.011). Canned beans were purchased by 66.5% of the women. Bicultural/English-dominant women had the highest purchases of canned beans (74.6%), followed by non-Hispanic White women (68.8%) and Hispanic-dominant women made the lowest purchases (51.1%). Further, fewer than 11% of the respondents ate beans five or more times per week. Bean consumption frequencies were highest for Hispanic-dominant and bicultural/English women at 3-4 times per week while most non-Hispanic White women ate beans 2-3 times.

Medard (2017) examined the household's consumption frequency of different beans and bean products among a random sample of 754 households in Tanzania. Descriptive statistics results revealed that dry red beans were the most frequently consumed followed by dry brown and dry mottled and purple beans. Dry black, dry mixed, dry yellow and dry cream beans were less frequently consumed with respondents reporting to consuming them once or more per week. Results further indicated that processed bean products were the least frequently consumed with no respondent reporting consuming them once or more per week, and almost 98% of them reporting never having consumed them at all. This was attributed to a lack of knowledge of alternative preparation methods and uses of beans in society. Further, there were no differences in consumption frequencies between households with male or female decision makers. However, there were little differences in consumption frequency between households with main decision makers from different age and education categories. Results from this study contradict those of Monge *et al*. (2019) who found that black beans (96%) and garbanzo beans (64%) are more frequently consumed compared to other bean types. However, the above studies (Medard, 2017; Monge *et al*., 2019; Winham *et al*., 2019) did a descriptive analysis of the consumption frequency of dry and canned beans. Therefore, to understand the factors that influence consumption frequency of various food products, the current study adopted a Zero Inflated Negative Binomial (ZINB) regression, thus, overcoming this challenge.

Seguin *et al*. (2016) employed a cross-sectional study to assess the consumption frequency of foods prepared away from home using an analytical sample of 1570 residents of King County, Washington. The study employed multivariate models to examine the relationship between foods away from home with body max index and fruit and vegetable consumption. The results showed

that the frequency of food away from home was significantly higher ($p<0.001$) among males (43.1%) than females (54%). Females reported significantly eating fruits and vegetables ($p<0.001$) more than their male counterparts. Further, the results indicated that a higher frequency of foods away from home was associated with a higher body mass index and fewer fruits and vegetable consumption. Likewise, Arechavala *et al*. (2016) found that females ate vegetables and fruits more frequently than males in secondary schools in Barcelona, Spain. However, males consumed junk food more frequently than females and thereby, boys had excess body weight compared to girls. The above studies (Arechavala *et al*., 2016; Seguin *et al*., 2016) carried out comparative studies on consumption frequencies between males and females. Therefore, to overcome this challenge, the current study focused on factors influencing the consumption frequency of PCB products in Machakos County, Kenya.

Choi *et al*. (2019) examined the associations between the frequency of consumption of whole fruit and fruit juice with obesity and metabolic syndrome among 10,460 adults aged 19 to 64 years in Korea. Descriptive statistics revealed that 32.6% of the respondents consumed whole fruit daily whereas 52.3% consumed fruit juice rarely. Further, results from logistic regression showed that consuming whole fruit one time a day or more was associated with a reduced prevalence of obesity and elevated blood pressure. However, the frequency of fruit juice consumption showed no association with obesity and metabolic syndrome. Likewise, Xavier *et al*. (2014) adopted descriptive statistics and binary logit to compare the frequency of consumption of fruits, vegetables and soft drinks among 4,207 adolescents aged 14-19 years living in urban and rural areas of Pernambuco state. The results showed that adolescent students who resided in rural areas had a prevalence of occasional consumption of natural fruit juices while those living in urban areas had a higher prevalence of daily consumption of soda drinks.

Aung *et al.* (2023) investigated the factors affecting consumption frequency of edible insects among 872 respondents in Myanmar using Poisson regression model. The study results found that concerns on safety, taste, smell, ethnicity, family size and income were factors influencing how often respondents consumed edible insects. However, the current study was investigating the factors that influence consumption frequency of PCB products. Thus, there are factors such as ethnicity and safety concerns that the current study did not consider.

2.8 Factors influencing consumption frequency for food products

Liu *et al*. (2020) employed an ordered Logit model to determine factors influencing the consumption of edible insects among 614 Chinese consumers from Beijing and Nanjing regions. The results revealed that insect phobia, feelings of disgust, knowledge level, age, household size, household income, and region influence purchase decisions. In addition, perceived positive attributes associated with edible insects, the preferences of children in the household, age and knowledge level had a positive influence on consumption frequency, while concerns about food safety and the shape of insects had negative impacts on consumption frequency. However, this study scantily captures the consumption of substitute foods as a factor influencing consumption frequency. Therefore, this study filled this gap. The study further suggests that educating consumers would increase their knowledge of edible insects which in turn would increase their probability to purchase insect foods. These results were consistent with those of Jolly *et al*. (2008), who found that age and education influence the frequency of groundnut consumption in Ghana.

Saghaian and Mohammadi (2018), assessed determinants affecting the frequency of fast-food consumption among 396 families in Mashhad, Iran using Poisson and negative binomial regression models. The results revealed that higher education levels, other meat consumption, awareness about the composition of fast food, and income had a negative and significant effect on fast food consumption frequency, whereas spouse occupation and availability of fast foods had a positive effect on fast food consumption frequency. Finally, the study found that with advertising, the frequency of fast-food consumption was expected to increase by 4%. Likewise, this study employed a Poisson regression model to determine factors that influence consumption frequency for PCB products. Further, Tomašević *et al*. (2020) carried out an online survey among 146 respondents to examine consumption frequency of foreign and domestic fast foods. Results from ordinal logistic regression model revealed that convenience of foods was the key factor which determines how regularly fast foods are consumed. The respondents were of various age, employment status, gender and qualifications as noted by the study. However, the study did not include these variables during analysis which could possibly influence frequency of consumption of fast foods. To overcome this challenge, the present study included the above-mentioned variables to determine consumption frequency for PCB products.

Nuani *et al*. (2022) adopted a negative binomial regression model to examine consumption frequency of roots and tubers among 385 respondents in Nakuru County, Kenya. The study results

indicated that monthly income, household health, household size, nutritional knowledge, farming of roots and tubers and availability of the various types of roots and tubers had an effect on the consumption frequency among urban households. However, this study results revealed a positive relationship between household size and consumption frequency of roots and tubers. The current study anticipates a negative relationship between household size and consumption frequency of PCB products. Thus, the present study employed a count data model to determine the relationship between household size and consumption frequency of PCB products.

Ndenga *et al*. (2017) investigated the factors influencing household consumption frequency for indigenous chicken among 200 respondents in Kenya. The study employed a multistage sampling technique to obtain the sample size and adopted descriptive statistics and binary logistic regression model for analysis. The results revealed that household size, gender, education, age, price and rearing of indigenous chicken are significant factors influencing consumption frequency of this types of chicken. These results corroborate those of Can *et al*. (2015) who found a positive correlation between education, income and consumption frequency of fish among 127 consumers. Likewise, Jolly *et al*. (2008) employed logistic models to determine factors that influence frequency of peanut consumption in Ghana. The results revealed that the form of consuming groundnuts, education and age influenced the frequency of consumption in humans. Further, knowledge on the nutrition benefits by poultry farmers influenced consumption frequency on birds. The studies did not consider consumption frequency as a count outcome. Therefore, the present study employed a zero inflated negative binomial regression model to analyze factors influencing consumption frequency, because the outcome variable of the study was a count.

Pettigrew *et al*. (2015) adopted a structural equation modelling to investigate determinants of frequency of consumption of soft drink among children aged between 8 to 14 years in Australia. The study conducted online interviews on 1302 parents to children of the age range. The results showed that parental attitudes toward soft drinks, children's demanding behavior, and perceived societal norms surrounding children drinking soft drinks all had an impact on consumption frequency. Likewise, Louis *et al.* (2022) examined consumption frequency of fish through an online survey across different consumer segments and regions in Brazil. The study explored several socio-economic characteristics of 1509 consumers of fish. According to the study findings, income levels, age categories, and geographic locations showed significant disparities in the

frequency, determinants, and habits of fish consumption. Additionally, the nutritional value, price, trust in the health quality of a product and culinary options were significant determinant relating to the consumption frequency of the different types of fish.

2.9 Theoretical framework

Two theories informed this research: random utility theory and theory of consumer behaviour. Random utility theory explains how consumers decide between many options. According to this theory, consumers select the product that maximizes their utility based on their preferences for various product features. The theory has been applied to describe how consumers behave when consuming food products, such as PCB products. On the other hand, the theory of consumer behaviour describes how consumers make decisions considering their constraints and preferences. According to Winter (2017), the theory postulates that consumers have preferences for various product attributes and select the product that best meets those needs. The theory has been applied to explain how consumers behave when consuming food products, such as PCB products. The rationale behind selecting these theories is their capacity to explain consumer behaviour concerning food product consumption. The theory of consumer behaviour offers a framework for understanding how consumers make decisions based on their preferences and constraints, while random utility theory offers a framework for understanding how consumers choose between various alternatives. Thus, this study was able to assess variables influencing consumer behaviour regarding consumption of PCB products by employing these theories.

2.9.1 Random utility theory

The main assumption of random utility theory is that consumers make rational decisions as they seek to maximize their net personal utility. However, behavioural research has shown that consumers do not always make well-calculated strategic decisions, contradicting the axioms of utility maximization's underpinnings (Lovreglio *et al*., 2016). This is due to decision-makers' inability to consistently handle information and generate perceptions. Many studies have revealed that decision-makers employ a range of "quick and dirty" probing to judge and make decisions (Lovreglio *et al*., 2016). Therefore, an attempt was made to account for some of the behavioural characteristics of judgments made under constraints. Thus, this study was based on the theory of consumer behaviour that assumes a consumer has preferences that are constrained by a given budgetary level.

2.9.2 Theory of consumer behaviour

This study was based on the theory of consumer behaviour which emphasizes the factors that determine the consumer decision making process. The theory seeks to predict the consumption patterns of individuals by making three assumptions about human behaviour: 1) consumers seek to maximize their utility, 2) there is non-satiation of wants and 3) marginal utility is decreasing. This theory also assumes that a rational consumer has complete knowledge about the market, is fully aware of his wants and able to determine the best way to maximize utility (Naidu, 2018). However, consumers do not have all the information about goods and services and the information they have is subject to perception and attitudinal biases. According to Hanf and Winter (2017), this theory suggests that consumers focus on a combination of different product attributes. In this case, consumers of PCB products focus on the cost-saving, long shelf-life, environmental conservation and nutrition and health benefits of these products.

Given tastes and preferences, consumers of PCB products maximize their utilities which are subject to budget constraints. The budget shows the economic fact of scarcity as it affects the individual consumer. According to the Marshallian economic model, consumers will spend their income on goods that offer them maximum utility, depending on their preferences and relative prices of other commodities. This shows the income and substitution effect of consumer behaviour (Naidu, 2018). The income effect arises as a result of an increase in purchasing power when the price of one commodity is lower within the bundle of commodities purchased by a consumer. Substitution effect refers to the extra purchase of PCB products after the price falls and they are relatively cheaper than other bean products in the market. Therefore, the core analysis of consumer behaviour is the interaction between price changes and consumer demand.

2.10 Conceptual framework

The conceptual framework (Figure 2.1), in this study, is built on improving households' food and nutrition security. It highlights the socio-economic, institution and market characteristics as well as product-related factors which are hypothesized to influence consumer awareness, preference, and consumption frequency for PCB products.

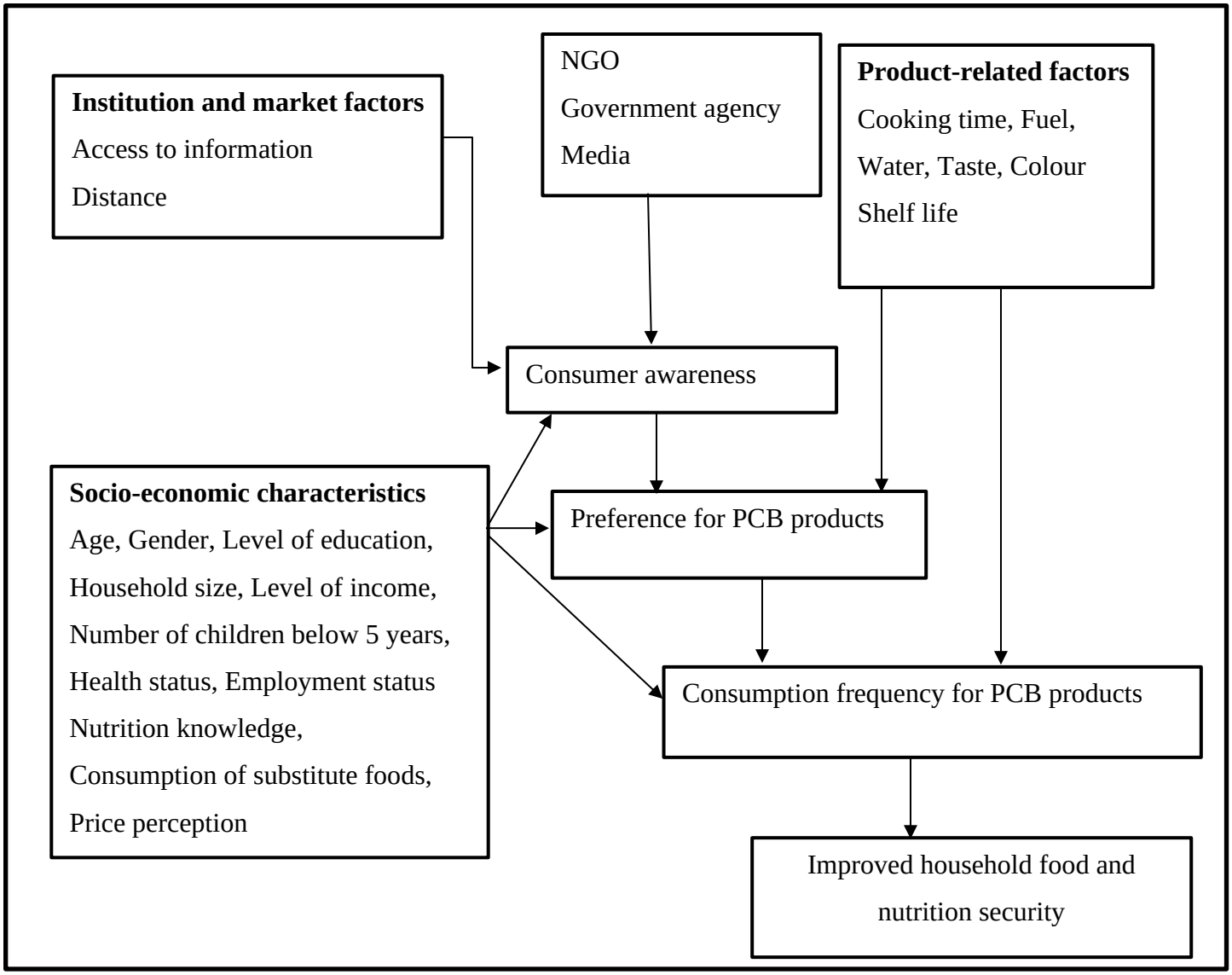

Figure 2.1: Conceptual framework

Socio-economic factors illustrated in Figure 2.1 include age, gender and level of education, income level, household size, number of children below the age of 5, health status of a household, employment status of the household head, if the household consumes substitute foods such as meat and dry beans, price perception and nutrition knowledge. Institution and market factors highlighted below are distance to the market and access to product information. The product related factors illustrated are cooking time, amount of water and fuel used, taste and colour as well as the shelf life of these bean products.

It is hypothesized that these factors influence consumer awareness, preference, and consumption frequency for PCB products. Consumer awareness is hypothesized to influence both preference and consumption frequency for PCB products. Consumer awareness is moderated by institutions such as media, Non-Governmental Organizations (NGOs) such as Caritas and CIAT and government agencies such as KALRO. Consumer preference for PCB products is also expected to influence the consumption frequency for these bean products. It is expected that an increase in awareness, preference and consumption frequency for PCB products will improve household food and nutrition security.

CHAPTER THREE
METHODOLOGY

3.1 Study area

This study was conducted in Machakos town sub county in Machakos County, Kenya (Figure 3.1). Machakos County borders Nairobi and Kiambu counties to the West, Kitui to the East, Embu to the North, Murang'a, and Kirinyaga to the Northwest, Makueni to the south, and Kajiado to the Southwest. It lies between latitudes 0^0 45' South and 1^0 31' South and longitudes 36^0 45' East and 37^0 45' East. The county has a total population of 1,098,584 with 264,500 households and covers an area of 6,208 square kilometres (KNBS, 2019.). The county has eight sub counties: Machakos town, Mavoko, Masinga, Yatta, Kangundo, Kathiani, Matungulu and Mwala. The county is within the greater Nairobi metropolitan area with most of its major towns being cosmopolitan.

Machakos County is one of the major bean corridors in Kenya and has a diverse population (Wambua *et al*., 2018). However, the county is characterized by a high food shortage which contributes to high incidences of malnutrition, where approximately 27 percent of children under 5 years are stunted, and 7 percent are wasted (MoALF, 2017). A nutrition survey done under the multiple indicator cluster surveys in 2008, indicates that the prevalence of stunting was 31 percent which was higher than the acceptable threshold, and underweight levels were at 17 percent which was also quite high (Machakos County, 2015). In addition, a study by Kishoyian *et al.* (2017) indicates that 24.3 percent of children under 5 years in Machakos county had severe malnutrition, 11.4 percent had moderate malnutrition, 44.3 percent had mild malnutrition and 20 percent were well nourished.

Machakos County is also characterized by water shortages. This is due to unsustainable sand harvesting which has led to a decrease in the water-holding capacity of rivers. In addition, 68 percent of the population in the county relies on wood as a source of energy for cooking whereas less than 1 percent use other sources of cooking such as solar and electricity (MoALF, 2017). This has led to deforestation which in turn has disrupted the water cycle. Water shortage has led to a decline in food production within the county, and this has affected the nutrition status of households in this county.

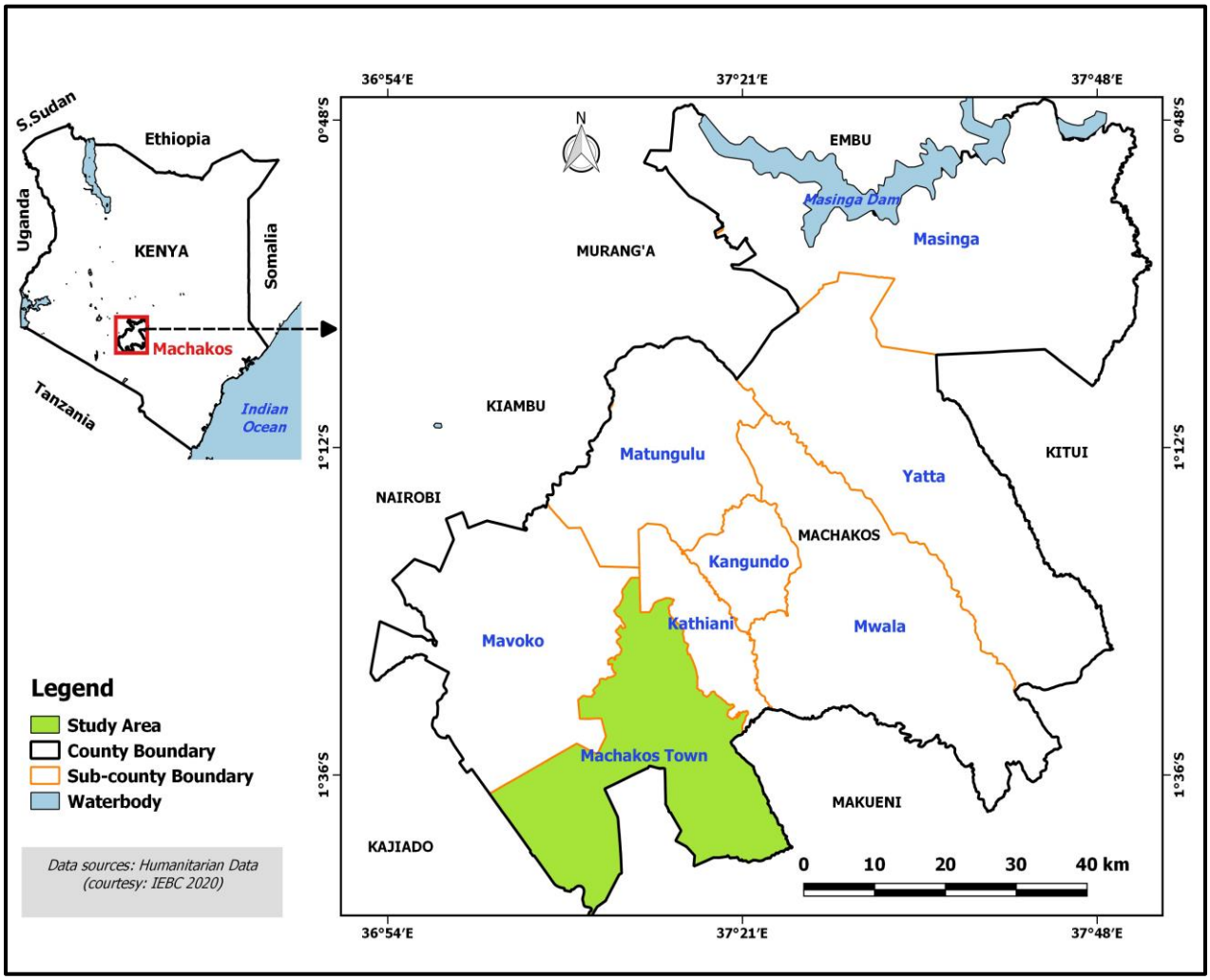

Figure 3.1: Map of the study area

Source: Humanitarian Data (*Courtesy: IEBC 2020*)

3.2 Research design

The present study is anchored on a cross-sectional data research design whereby data from both consumers and non-consumers of PCB products is collected at a single point in time. A cross-sectional research design is useful for this study because much information is obtained in a relatively short time and allows data collection at one point in time from a different group of respondents.

3.3 Sample size determination

To determine the sample size, this study adopted the sample size formula of Cochran (1977):

$$n = \frac{pqz^2}{e^2} \tag{3.1}$$

where; n= desired sample size, p = estimated proportion of the population, q is the weighted variable and is calculated as $q = 1 - p$, Z is the number of standard deviations from the mean and e= is the acceptable margin of error for the proportion being estimated.

Therefore, the sample size is:

$$\frac{0.5 \times 0.5 \times 1.96^2}{0.05^2} = 384.16 \cong 385 \text{ respondents} \tag{3.2}$$

The estimated proportion was set at 0.5, since a proportion of 0.5 leads to a suitable and reliable sample size when dealing with an infinite population. The margin of error was set at 0.05 (5%). From 385 respondents, roughly equal proportions were allocated for both consumers of PCB products and non-consumers of these bean products. The respondents that were interviewed were distributed in the seven wards of Machakos town sub county (Table 3.1) according to the data from KNBS, (2019).

Table 3.1: Distribution of sample size in the wards

Ward	Population	Percentage in proportion	Number of households
Mutituni	23,736	11.92	46
Kola	24,585	12.34	47
Mua	25,573	12.82	49
Mumbuni North	28,319	14.22	55
Kalama	32,055	16.09	62
Muvuti/Kiima-kimwe	32,413	16.27	63
Machakos central	32,530	16.33	63
Total	199,211	100	385

3.4 Sampling procedure

This study employed a multistage sampling technique. In the first stage, Machakos county was purposively selected because the processing of PCB products is done within the county. In addition, the Global Alliance for Improved Nutrition (GAIN) which looks at how food systems can improve diets for the most vulnerable, is established in this county. In the second stage, Machakos town sub county was purposively selected because it has benefited from bean research intervention by KALRO. In the third stage, a list of consumers of PCB products was obtained from KALRO and a systematic sampling technique was employed in selecting 193 consumers. Finally, a systematic random sampling technique was applied in selecting 192 non-consumers of PCB products. To carry out systematic random sampling, a sampling interval was determined, which was the number of households between each selection. In this case, the sampling interval was 4. So, the enumerators started at any household in the sub county and selected every fourth household until the desired sample size was reached. This included asking whether the respondent was a non-consumer of PCB products, and if not the case; the immediate household was interviewed.

3.5 Method of data collection

This study relied on primary data collected from the field. A semi-structured questionnaire was the main primary tool for the collection of both quantitative and qualitative data. The questionnaire had both open and closed-ended questions. The questionnaire contained information on market and product-related factors, socioeconomic characteristics as well as PCB products consumption patterns among the households. The study employed a face-to-face interview schedule as means of collecting data which was administered by trained enumerators. Data was collected in October 2022.

3.6 Validity of the instrument

Before the actual interview, a pre-test was conducted in Machakos Town sub county among 25 respondents to ensure the instrument's validity. During the pre-test, the sampled questionnaires were extensively reviewed for precision to determine whether they accurately represented the study's variables. A well-organized training session enabled the enumerators to become acquainted with the instrument. This reduced the possibility of variable misrepresentation and misinterpretation.

3.7 Data analysis

Data cleaning and analysis were done using STATA for descriptive, Multivariate Probit model and Poisson regression models. The analysis focused on factors hypothesized to influence consumer awareness, consumer preference and consumption frequency for PCB products.

3.7.1 Analytical framework

Objective 1: To determine consumer awareness of PCB products in Machakos county.

Consumer awareness is a binary outcome where respondents could be aware of PCB products or not. Under this objective, all the four PCB products available in the market were studied, that is, the packed beans, bean snacks, bean noodles and bean flour. Therefore, the outcome variable was the level of consumer awareness. A proportion equal to one was used to assess the level of consumer awareness in Machakos County. To examine this goal, descriptive statistics such as percentages, mean, and standard deviation were used. Descriptive statistics have previously been used to examine the level of consumer awareness of various food products (Hettiarachchi *et al*., 2019; Jain *et al*., 2018; Lutomia *et al*., 2021; Popek & Halagarda, 2017). The results of the present study are presented in tables and graphs.

Objective 2: Factors influencing consumer preference for PCB products in Machakos County.

The PCB products that were studied in this objective are packed beans, bean snacks, bean noodles and bean flour. A household preferred one or more of the PCB products if and only if the expected utility was higher than otherwise. Preference was measured by the probability of choosing either or all of the PCB products. Therefore, the dependent variable (y_i) was a dichotomous variable indicating whether a household preferred the selected PCB products or not.

$$y_i = \begin{cases} 1, & if \quad prefers \\ 0, & otherwise \end{cases} \tag{3.3}$$

Preference for PCB products could be modelled in two ways, by either multinomial or multivariate regression analysis. Multinomial models assume independence of alternatives, that is, error terms of the choice equations are mutually exclusive (Mittal & Mehar, 2016). However, preferences among the PCB products are not mutually exclusive as consumers could prefer more than one product at a time. This could lead to an unobserved correlation in the error terms of each equation. Univariate Probit or Logit models assume that the error terms are distributed

independently (Temesgen *et al*., 2017), ignoring the correlations in the outcomes hence leading to inefficient parameter estimates. Multivariate Probit (MVP) is thus appropriate as it holds the assumption that there is correlation and interdependence in the household's preference for PCB products. This model is often used to estimate more than one correlated binary outcome jointly. Therefore, this study employed MVP. Generally, the model can be specified as follows:

$$y_i^* = \beta_0 + \beta_1 x_i + \varepsilon_i \tag{3.4}$$

where y_{ij}^* is the unobserved latent variable showing the probability of choosing a given PCB product by consumer i, β_i is a vector of parameters to be estimated, χ_i is a vector of explanatory factors and ε_i is the random error term.

Table 3.2: Description of variables for Multivariate Probit model

Variables	Description and measurement	Sign
Dependent variables		
Packed PCBs	If respondents consume packed beans (1=Yes, 0=No)	
PCB flour	If respondents consume PCB flour (1=Yes, 0=No)	
PCB snack	If respondents consume PCB snacks (1=Yes, 0=No)	
PCB noodles	If respondents consume PCB noodles (1=Yes, 0=No)	
Independent variables		
Age	Age of the decision maker in years (Continuous)	±
Gender	If the decision maker is female (1=Yes, 0=No)	±
Education	Number of years in school (Continuous)	±
Household size	Number of household members (Continuous)	±
Child below 5 years	Number of children below 5 years (Continuous)	±
Employment	If the decision maker is in employment (1=Yes, 0=No)	±
Monthly income	Monthly income of the decision maker in Kshs (Continuous)	±
Health status	Number of household members with an underlying health condition (Continuous)	±
Market distance	Distance from home to the market in Kms (Continuous)	-
Cooking time	If the cooking time of PCB products influences preference (1=Yes, 0=No)	±
Fuel	If the quantity of fuel used in preparing PCB products influences preference (1=Yes, 0=No)	±
Water	If the quantity of water used in preparing PCB products influences preference (1=Yes, 0=No)	±
Taste	If the taste of PCB products influences preference (1=Yes, 0=No)	±
Colour	If the colour of PCB products influences preference (1=Yes, 0=No)	±
Shelf life	If the shelf life of PCB products influences preference (1=Yes, 0=No)	±

Table 3.2 shows dependent and independent variables, their description and the expected signs. Factors hypothesized to influence preference were age, gender, education level, household size, level of income, presence of children below 5 years, health status, employment status, distance to the market, cooking time and amount of fuel and water used, taste, colour and shelf-life. To identify factors influencing preference for selected PCB products, continuous and discrete variables were based on empirical studies (Ahmed *et al*., 2020; Aseete *et al*., 2018; Atilola, 2018; Hagan & Vitor, 2020; Teweldemedhin & Mulonda, 2016).

It was hypothesized that preference for PCB products could be correlated, thus error terms might experience stochastic dependence. The error terms are assumed to be multivariate and are normally distributed with a mean of zero (Mittal & Mehar, 2016). The off-diagonal elements allow for correlation across the error terms of equations showing the unobserved factors that influence the choice of alternatives.

$$\Omega = \begin{pmatrix} 1 & p_{X^1 X^2} & p_{X^1 X^n} \\ p_{X^2 X^1} & 1 & p_{X^2 X^n} \\ p_{X^n X^1} & p_{X^n X^2} & 1 \end{pmatrix} \tag{3.5}$$

Objective 3: Factors influencing consumption frequency for PCB products among households in Machakos County.

The dependent variable is the sum of times a household consumes these bean products, despite the type of PCB product consumed in a typical month. Therefore, the outcome variable in this objective is a count taking a value greater than zero if a household consumes PCB products and a value of zero if a household does not consume these products. A non-negative outcome variable is negatively skewed implying that Ordinary Least Squares (OLS) parameter estimates would be biased and inefficient (Mwololo *et al*., 2019). Consequently, a Poisson probability distribution would be more appropriate than a normal or logistic distribution since it is not limited to specific values. According to Mwololo *et al*. (2019), Poisson distribution captures the positive and discrete nature of the count outcome variable and allows inference to be drawn based on probabilities of an occurrence. Moreover, the equal dispersion assumption of the model accounts for skewness in count data. Therefore, this study employed a Poisson regression model. The probability density function can be defined as:

$$f\left(Y_i|x_i\right)=p\left(Y_i=y_i\right)=\frac{e^{\lambda}\lambda^{y}}{y!} \tag{3.6}$$

where Y_i is the random Poisson variable, y_i is the number of times a household consumed PCB products, χ_i are the variables that determine the consumption frequency including age, gender, education level, household size, level of income, presence of children below 5 years, health status, employment status, consumption of substitute foods, distance to the market, price perception, nutrition knowledge, cooking time, taste, colour and shelf life as well as the amount of fuel and water used. λ is the expected mean parameter of the probability function which can be defined as:

$$E(y_i \mid x_i) = \lambda_i = \exp(x_i^{'}\beta) \tag{3.7}$$

The aforementioned equation represents the Poisson data count regression model where β parameters can be estimated using the maximum likelihood technique (Carrer *et al*., 2017). This technique is done by maximizing the following log-likelihood function:

$$\ln L = \ln\left[\frac{e^{\lambda}\lambda^{y}}{y!}\right] = -\lambda + y_i \ln(\lambda) - \ln y_i = -\exp(x_i^{'}\beta) - \ln(y_i!) \tag{3.8}$$

The Poisson model assumes equal dispersion of data, that is, the variance function is equal to the conditional mean of the data. However, most real-life data is characterized by over-dispersion and excess zeros caused by the non-consumption of PCB products. Use of the standard Poisson model in count data with excess zeros leads to consistent but inefficient estimates, leading to over-estimation or invalidation of standard errors and wrong inference (Mahama *et al*., 2020). To overcome this, a Zero-inflated Poisson (ZIP) regression model could be used. However, the ZIP regression model does not work where the count data exhibits over-dispersion. The negative binomial regression (NBR) model, could be used to deal with the problem of over dispersion (Mwololo *et al*., 2019).

The choice of variables used in the model were based on literature (Aseete *et al*., 2018; Liu *et al*., 2020; Saghaian & Mohammadi, 2018). Table 3.3 shows the dependent and independent variables chosen and the expected signs.

3.7.2 Diagnostic tests

To determine whether there was any collinearity among the explanatory variables, a Variance Inflation Factor (VIF) test for multi-collinearity was done. The selected variables' VIF mean was 1.21, which was within a reasonable range. According to the general rule of thumb, VIF values over 4 indicate a need for more investigation, while VIF values over 10, points to multi-collinearity that has to be addressed (Selassie, 2020). Additionally, the data was evaluated for heteroscedasticity, and the study rejected the null hypothesis that there was no presence of heteroscedasticity in the data since the *p*-value (P=0.0000) was considered significant. To account for heteroscedasticity and produce robust standard errors, robust models of MVP and ZINB models were run.

Table 3.3: Description of variables for Poisson regression model

Variables	Description and measurement	Sign
Dependent variable		
Consumption frequency	Number of times a household consumes PCB products in a month	
Independent variables		
Age	Age of the decision maker in years (Continuous)	±
Gender	If the decision maker is female (1=Yes, 0=No)	±
Education	Number of years in school (Continuous)	±
Household size	Number of household members (Continuous)	±
Child below 5 years	Number of children below 5 years (Continuous)	±
Monthly income	Monthly income of the decision maker in Kshs (Continuous)	±
Health status	Number of household members with an underlying health condition (Continuous)	±
Employment	If the decision maker is in employment (1=Yes, 0=No)	±
Substitute	If the household consumes substitute foods (1=Yes, 0=No)	-
Market distance	Distance from home to the market in Kms (Continuous)	-
Price perception	If the household perceives PCB products affordable (1=Yes, 0=No)	±
Nutrition knowledge	If the respondent is knowledgeable about the nutrition of PCB products (1=Yes, 0=No)	±
Cooking time	If the cooking time of PCB products influences consumption frequency (1=Yes, 0=No)	±
Fuel	If the quantity of fuel used in preparing PCB products influences consumption frequency (1=Yes, 0=No)	±
Water	If the quantity of water used in preparing PCB products influences consumption frequency (1=Yes, 0=No)	±
Taste	If the taste of PCB products influences consumption frequency (1=Yes, 0=No)	±
Colour	If the colour of PCB products influences consumption frequency (1=Yes, 0=No)	±

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Descriptive analysis

This study examined both the consumers and non- consumers of PCB products. During data analysis, consumers of PCB products were assigned the value of 1 whereas the non-consumers were given the value of zero.

4.1.1 Socioeconomic characteristics of respondents in Machakos County

The socioeconomic characteristics of respondents are presented in Table 4.1 and Table 4.2. The study results in Table 4.1 reveal that decision makers in consumer households of PCB products had spent more years in school compared to those in non-consuming households, with an average of 12 years and 11 years**,** respectively. The two-tailed t-test results indicate that education is statistically significant at 1% implying that there is a significant mean difference in education of decision makers in consumer and non-consumer households. Therefore, it is possible that the higher level of education among decision makers in consumer households could be a contributing factor to their consumption of PCB products. Individuals with higher education levels are associated with consuming healthier diets as compared to those with low education levels who are associated with consuming diets high in carbohydrates and low in fibre (Fard *et al*., 2021).

Table 4.1: Socioeconomic characteristics of respondents (continuous)

	Mean			
Variables	**Consumers**	**Non-consumers**	**Overall**	**t-test**
Age (Years)	41.4249	41.8490	41.6364	0.4046
Education (Years)	12.4249	11.0573	11.7429	-4.5207***
Household size (Number)	3.3679	5.5677	4.4649	10.2863***
Children below 5 years (Number)	1.5751	1.3594	1.4675	-1.8537*
Monthly income (Kshs)	18666.1700	12246.3100	15464.5800	-5.6767***
Market distance (Kms)	1.3425	2.5427	1.9410	7.3435***
Health status (Number)	0.8808	0.2083	0.5455	-10.1468***

* and *** represents 10% and 1% significance levels respectively

The mean household size was approximately 3 members for consumer households and approximately 6 members for non-consumer households. Two tailed t-test results indicate that household size was statistically significant at 1 percent implying that the average household size in consumer and non-consuming households was significantly different. Therefore, the study results suggest that household size has a significant effect on consumption of PCB products. Consistent with the findings of this study are those of Aseete *et al.* (2018) who found that PCB enthusiasts had smaller household sizes.

The study results further suggest that consumer households have more children below the age of five compared to non-consumer households, with an average of 2 children and 1 child**,** respectively. Two-tailed t-test results indicate that children below the age of five were statistically significant at 5% implying that the average number of children in consumer and non-consumer households was significantly different. Therefore, it is possible that the higher number of children in consumer households could be a contributing factor to their consumption of PCB products. The PCB products have abundant proteins, vitamins, and minerals which are essential for a child's growth and development.

The average income of decision makers in consumer households of PCB products was approximately 18,666 Kshs**,** while that of non-consuming households was approximately 12,246 Kshs. Two-tailed t-test results indicate that monthly income was statistically significant at 1% implying that there was a significant difference between the mean income of decision makers in consumer and non-consumer households. Thus, it is likely that the higher income levels of decision makers in consumer households have a role in their decision to consume PCB products. This is consistent with the findings of Dominguez-Viera *et al*. (2022), who found that higher-income consumers have a higher willingness to pay for healthy varieties of processed foods compared to low-income consumers.

The average distance from home to the nearest market for consumer households was 1.3 kilometers while that for non-consumer households was 2.5 kilometers. Two tailed t-test results indicate that market distance was statistically significant at 1 percent implying that the average market distance between consumer and non-consumer households was significantly different. This implies that the consumption of PCB products may be constrained by a wide market distance.

In consumer households, the mean number of household members living with medical condition was 1. The number of individuals living with a medical condition was used as proxy measure for household health status. Two tailed t-test results indicate that health status was statistically significant at 1 percent implying that there was a significant difference between the health status of consumer and non-consumer households. Thus, it is possible that the presence of a household member with an underlying health condition in consumer households could be a contributing factor to their consumption of PCB products. Bean based products are packed with nutrients and are a healthy substitute for animal protein.

Table 4.2: Socioeconomic characteristics of respondents (categorical)

		Percentage			
Variables		**Consumers**	**Non-consumers**	**Overall**	**Chi-square**
Gender	Female	52.85	43.75	48.31	3.1916*
	Male	47.15	56.25	51.69	
Employment	Yes	77.20	51.04	64.16	28.8724***
	No	22.80	48.96	35.84	

* and *** represents 10% and 1% significance levels respectively

The study results in Table 4.2 suggest that females make up the majority of decision makers in consumer households of PCB products, with a percentage of 53%**,** while males are the majority in non-consumer households, with a percentage of 56%**.** Chi-square results indicate that gender is statistically significant at 10% implying that the gender of decision makers in consumer and non-consumer households is statistically different. In most households, women prepare majority of the meals (Schaeffer, 2019). Thus, consumption of PCB products liberates women from spending a significant amount of time on meal preparation, allowing them to complete other household tasks and engage in other productive activities.

The proportion of decision makers in consumer households who are in employment was 77% and those in non-consuming households was 51%. Chi-square results show that employment was statistically significant at 1 percent indicating that there were significant differences between the employment status of decision makers in consumer and non-consumer households. Individuals

who are in employment might have little time to prepare meals, so the majority of them prefer PCB products which are quick to prepare to dry beans.

4.1.2 Level of awareness of PCB products among households

The level of consumer awareness of PCB products was expressed as a proportion ranging from 0 to 1. Respondents were assigned a score of 0 if they were not aware of any PCB products, 0.25 if they were aware of one, 0.5 if they were aware of two, 0.75 if they were aware of three, and 1 if they were fully aware of all four products. Therefore, the level of consumer awareness of PCB products was measured on a scale from 0 to 1 based on the number of PCB products that a respondent was aware of.

According to the study results in Figure 4.1, 52% of the respondents were aware of at least one of the PCB products, while 48% were not aware of any PCB product. These findings suggest that majority of households in Machakos County are knowledgeable about the existence of PCB products. However, these results are inconsistent with those of Lutomia *et al.* (2021) who found that less than a quarter (22%) of the sampled population were aware of PCB products. The unit of analysis by Lutomia *et al*. (2021) was the net bean consumers, whereas the unit of analysis of the present study involved both the consumers and non-consumers of PCB products, which could explain the discrepancy in the results.

The results in Figure 4.1 also indicate that 9% of the respondents were aware of all the four PCB products. In addition, 8% of the respondents were aware of three products, whereas 17% and 18% were aware of two and one PCB products, respectively.

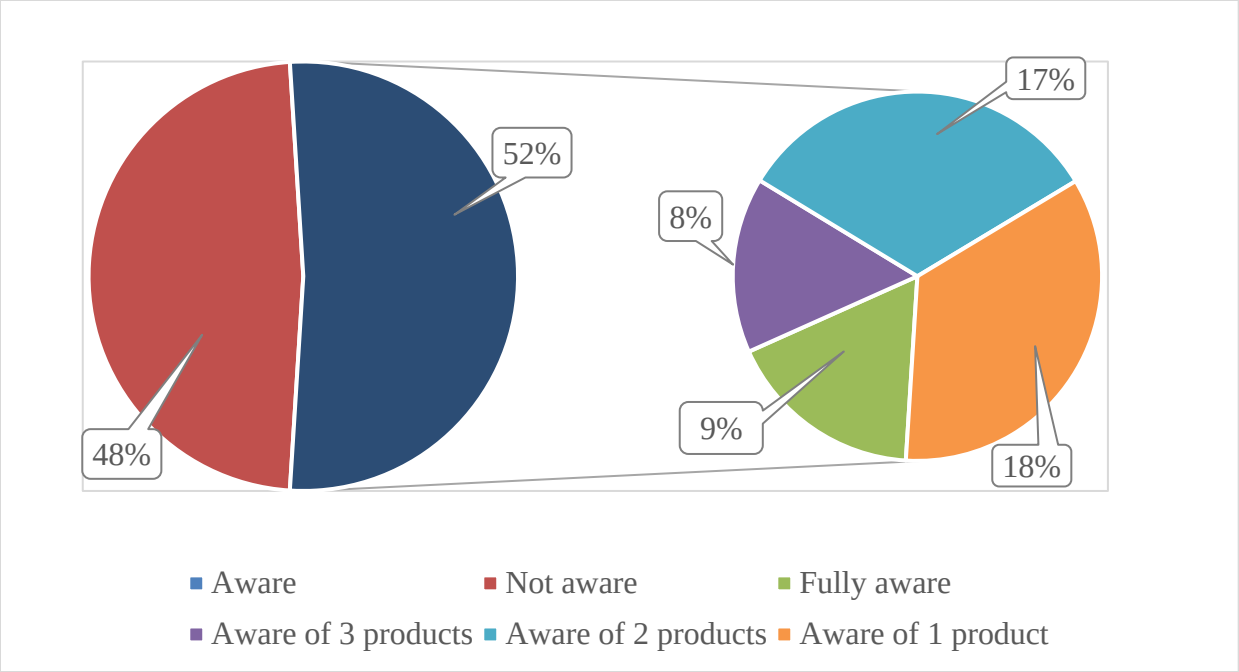

Figure 4.1: Consumer awareness of PCB products

Additionally, out of the four PCB products that were examined, the study found that 48% of the respondents were aware of the packed beans, 28% of the bean snack, 18% of the bean flour and only 6% were aware of the bean noodles. Further interrogation revealed that majority of PCB product promotions that the respondents had encountered both online and in person, were mainly focused on the packed beans. In addition, majority of survey participants who were aware of these products revealed that their friends were the main source of knowledge. These findings are in support of those of Ugen *et al*. (2021), who found that friends (68%) are an important source of information for PCB consumers.

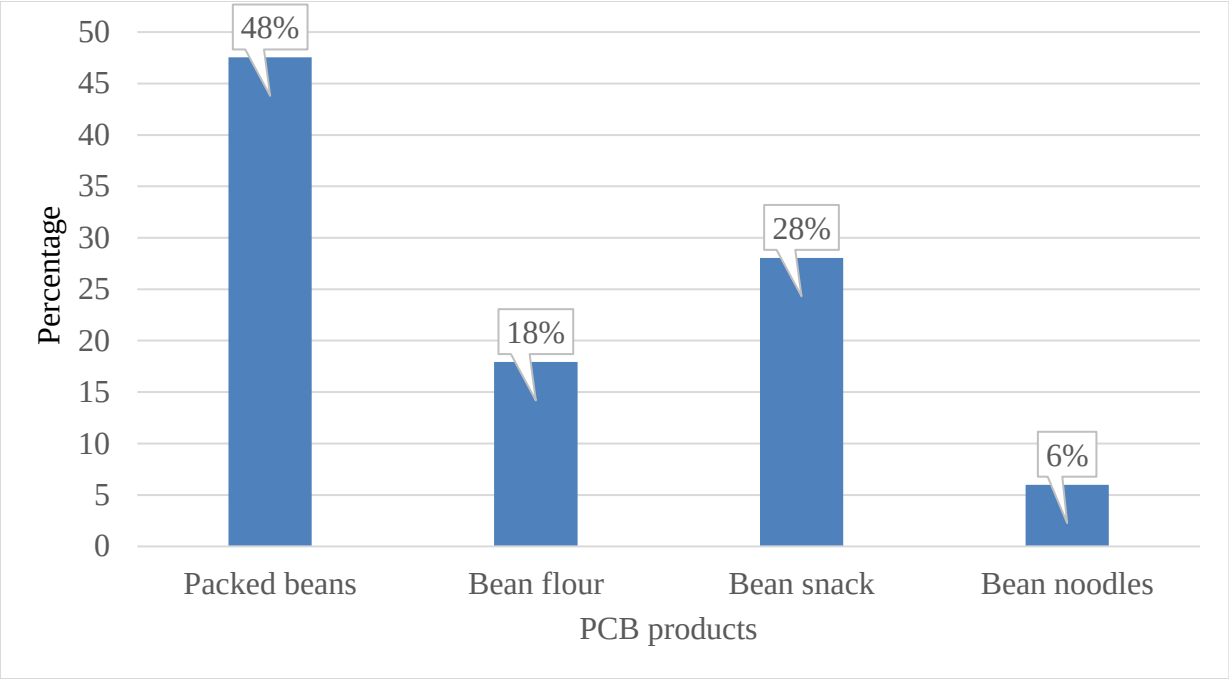

Figure 4.2: Consumer awareness for specific PCB products

4.1.3 Description of consumer preference for selected PCB products

According to descriptive statistics in Figure 4.3, packed beans are the most preferred product (43%) compared to other PCB products in the market. These findings concur with those of Ugen *et al*. (2021), who observed that packed beans (87%) are the most consumed PCB product. In contrast, the study by Ugen *et al*. (2021) indicated that bean snacks (11%) were the second most consumed PCB products in Kisumu County, which contradicts the current study's findings that found bean flour (37%) to be the second most consumed in Machakos County. In-depth probing indicates that households are accustomed to preparing packed beans for bean stew as compared to bean flour for porridge and soup thickening. The respondents also reveal that packed beans are preferred because cooked beans made from the common dry beans have a short shelf life and need to be refrigerated to prevent spoilage, which presents a challenge to most households.

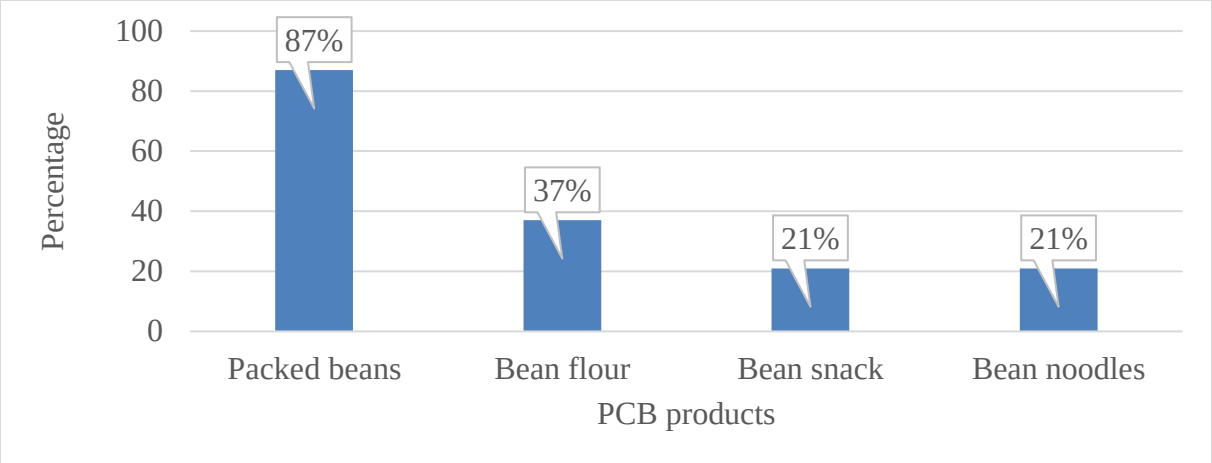

Figure 4.3: Consumer preference for PCB products

4.1.4 Consumption frequency for PCB products

Descriptive results presented in Table 4.3 reveal that packed beans are the most frequently consumed at 4 times on average, followed by PCB flour consumed at 3 times. Further probing indicates that the packed beans are used to make *githeri*, a common dish in Machakos County, which is made from a combination of beans and maize. In addition, the respondents revealed that they prepare bean stew from the packed beans, which is served as an accompaniment to main meals such as rice and stiff porridge (*ugali*).

Table 4.3: Monthly consumption frequencies for PCB products

PCB products	Mean	Percentage of consumers	Min	Max
Packed beans	4.15	35%	0	10
Bean flour	3.12	26%	0	10
Bean noodles	2.62	16%	0	6
Bean snack	2.62	10%	0	8

4.2 Factors influencing consumer preference for selected PCB products among households in Machakos County.

To determine factors influencing the selected PCB products, MVP model was used. The results of the MVP model are presented in Table 4.4. The Wald chi-square was 1785.09, the log

pseudo likelihood was 373.6477 and the likelihood ratio test of 62.8246 was significant at 1 percent. This implies that the MVP model was significant indicating that the explanatory variables included in the model had adequate explanatory power to explain consumers' preference for PCB products.

Table 4.4: Results from Multivariate Probit model on factors influencing consumer preference for PCB products.

	Packed beans		PCB flour		PCB snack		PCB noodles	
Variables	**Coeff**	**Std. Err**	**Coeff**	**Std. Err**	**Coeff**	**Std. Err**	**Coeff**	**Std. Err**
Age	-0.0014	0.0110	0.0116	0.0106	0.0036	0.0109	0.0109	0.0098
Gender	0.4158*	0.2156	0.0737	0.1816	-0.1574	0.2036	0.0048	0.1912
Education	0.0653	0.0440	0.0026	0.0391	0.0604	0.0380	-0.0008	0.0363
Household size	-0.4046***	0.1160	-0.1013	0.0646	-0.2742**	0.0975	-0.1651*	0.0879
Child_5 years	0.4652**	0.1605	0.0661	0.1138	0.3518**	0.1413	0.0735	0.1378
Employment	0.2798	0.2342	0.6840***	0.1940	0.4643**	0.1954	0.4852**	0.2315
Monthly income	0.2788**	0.1358	0.1527	0.1099	0.1618	0.1174	0.2539**	0.1122
Health status	0.0184	0.1504	0.2700**	0.1232	0.4691**	0.1364	0.3292**	0.1287
Market distance	-0.1857**	0.0786	-0.0640	0.0701	-0.0903	0.0904	-0.0348	0.0830
Cooking time	-1.4166***	0.2600	-0.3964	0.3308	-0.8482**	0.3700	-0.2663	0.3491
Fuel	-1.0739***	0.2930	-0.3732	0.3383	-0.3982	0.3159	0.0205	0.3250
Water	- 0.0882	0.3107	-0.1204	0.2624	-0.1606	0.2668	0.4148	0.2780
Taste	-0.2135	0.3331	-0.2504	0.2489	0.2088	0.2620	-0.0786	0.2622
Colour	0.3138	0.3618	-4.5713***	0.3568	-0.1303	0.7450	0.6595	0.5905
Shelf-life	0.1139	0.2621	0.6988**	0.2308	0.1938	0.2518	0.3397	0.2471

L.R test x^2 (6) = 62.8246, Wald x^2 (60) =1785.09, Log pseudo likelihood = -373.64773 Prob > x^2 =0.0000.

*, ** and *** represents 10%, 5% and 1% significance levels, respectively

From the findings, gender was found to have a significant and positive effect on preference for packed beans at 10% significance level. Being female increases the probability of choosing packed beans by 0.4158 units, holding other variables constant. This implies that females have a higher preference for packed beans than males. According to Schaeffer (2019), women are mostly the ones involved in cooking in most households. Therefore, females will prefer packed beans over other types of beans because they are easier and faster to prepare, which saves time and effort in the kitchen. These findings are in support of those of Hagan and Vitor (2020) who found that gender had a positive and significant effect on consumer preference for imported rice.

Household size was found to have a negative and significant influence on consumer preference for packed beans, PCB snack and PCB noodles at 1%, 5% and 10% significance levels respectively. An increase in household size decreases the probability of choosing packed beans by 0.4046 units, PCB snack by 0.2742 units, and PCB noodles by 0.1651 units, holding other variables constant. This implies that larger households have a lower preference for these products than smaller households, possibly due to budget constraints or different tastes. According to Rosana *et al*. (2020), households with four or more individuals spend more money on food than households with fewer members. Therefore, larger households may prefer to purchase cheaper food options that are more filling and can feed more people. Packed beans, PCB snacks and PCB noodles may not be the most cost-effective option for larger households, which could explain why they are less preferred by this demographic. These results support those of Aseete *et al.* (2018) who found that precooked beans enthusiasts had small household sizes.

Presence of a child under 5 years old in a household was found to have a significant and positive influence on consumer preference for packed beans and PCB snack at 5% significance level. Having a child under 5 years old increases the probability of choosing packed beans by 0.4652 units and PCB snack by 0.3518 units, holding other variables constant. This implies that these products are more appealing to households with young children, perhaps because they are nutritious, easy to prepare, or tasty. These results corroborate those of Meng *et al*. (2019) who found that presence of a child in a household influenced consumer preference for roasted groundnuts.

Employment was found to have a positive significant effect on consumer preference for PCB flour, PCB snack and PCB noodles at 1% and 5% significance levels respectively. Being

employed increases the probability of choosing PCB flour by 0.6840 units, PCB snack by 0.4643 units, and PCB noodles by 0.4852 units, holding other variables constant. This implies that employed people have a higher preference for these products than unemployed people, possibly because they have higher incomes, less time for cooking, or more exposure to new products. According to Rehman and Jamil (2016), individuals in employment are susceptible to various levels of information, valuation and utility influence from their work colleagues when making decisions on which products to purchase. Therefore, if a household head is employed, they are likely to purchase these PCB products if their colleagues or peers recommended them. Consistent with these findings are those of Atilola (2018) who found that employment status of the household head had a significant positive effect on consumer preference for yellow, purple and mixed yellow beans.

Monthly income had a positive and significant influence on preference for packed beans and PCB noodles at 5% significance level. An increase in monthly income increases the probability of choosing packed beans by 0.2788 units and PCB noodles by 0.2539 units, holding other variables constant. This implies that these products are more affordable or desirable for higher-income households than lower-income households. Individuals with high incomes have higher purchasing power compared to those with low levels of income. Additionally, individuals with high income levels are considered able to try out particular foods that have a variety of attributes, with the assumption being that various attributes implicitly refer to different quality and utility levels (Ogundele, 2014). These results support those of Kilima and Bolle (2020) who found a significant positive relationship between the income status of a household and its' expenditure on the selected bean varieties.

Consumer preference for PCB flour, PCB snack and PCB noodles was found to be positively influenced by health status of a household at 5 percent significance level. An increase in the number of household members living with a medical condition increases the probability of choosing PCB flour by 0.2700 units, PCB snack by 0.4691 units, and PCB noodles by 0.3292 units, holding other variables constant. This implies that these products are perceived as healthier or more suitable for people with medical conditions. This suggests that the diet of a household member living with a medical condition may have an impact on what the whole household consumes. Therefore, if a household member is living with a medical condition, it is likely that the household is knowledgeable of the importance of nutrition and health. This could lead to an

increased preference for PCB flour, PCB snacks and PCB noodles as they are convenient and nutritious options. These results corroborate those of Cheah (2014), who found that using products and services that promote health was strongly correlated with having a hypercholesterolemia diagnosis.

Market distance had a negative and significant influence on preference for packed beans at the 5 percent significance level. An increase in market distance decreases the probability of choosing packed beans by 0.1857 units, holding other variables constant. This implies that packed beans are less accessible or convenient for households that live farther away from the market than households that live closer to the market. However, these findings are contrary to those of Nuani *et al*. (2022) who revealed that sweet potato preference was positively influenced by distance to the market. Nuani *et al*. (2022) established that distant markets were close to where consumers worked and proved convenient for buying sweet potatoes on the way home from work.

Consumer preference for packed beans and PCB snacks was found to be negatively and significantly influenced by cooking time at 1 percent and 5 percent significance levels respectively. An increase in cooking time decreases the probability of choosing packed beans by 1.4166 units and PCB snack by 0.8482 units, holding other variables constant. This implies that these products require less time to cook and that households prefer products that are faster to cook. Results from further probing shows that consumers prefer products that will enable them to spend less time in the kitchen, preparing meals. In addition, consumers revealed that they preferred the packed beans because it requires less time to cook, which is between ten and fifteen minutes. Further, consumers are drawn to the PCB snack since it is a ready-to-eat food that does not need further processing, that is, requires zero cooking time. Therefore, these PCB products are a more convenient option for consumers who are short on time or do not want to spend too much time cooking. Similarly, Aseete *et al*. (2018), found that consumers preferred processed beans due to reduced cooking time thus minimizing costs and preferred convenience, which was reflected in their willingness to pay for it.

Preference for packed beans was also found to be influenced by fuel at 1% significance level. An increase in fuel decreases the probability of choosing packed beans by 1.0739 units, holding other variables constant. This implies that packed beans require less fuel to cook and that households prefer products that are more energy efficient. Consumers indicated that they prefer products that require less fuel in meal preparation. Further interrogation revealed that packed beans

require less time to cook and therefore use less fuel which has led to many consumer households using gas as energy for cooking. According to Ugen *et al*. (2021), the introduction of packed beans led to a significant gradual shift away from the use of firewood toward the use of charcoal and gas. As a result, the method of cooking packed beans has changed from using wood-based fuel to using clean energy. It costs approximately 47.44 Ksh to prepare a meal from packed beans instead of the 80.15 Ksh needed when preparing the same meal from dry beans, generating a savings of 32.71 Ksh (Ugen *et al*., 2021).

Colour was found to have a significant negative influence on preference for PCB flour at 1 percent significance level. This implies that PCB flour has a less appealing colour than other products, and that households prefer products that have a more attractive colour. In depth probing indicated that consumers primarily use packed beans to make bean sauces because they liked the brown colour of the sauces. Byarugaba *et al*. (2020), assert that processing improved consumer preference for bean sauces and that, in contrast to other sensory qualities, appearance was a primary factor for preference. According to the above-mentioned study, the brown colour had a significant positive influence on consumers' preferences for bean sauces. However, the present study found colour to have a negative influence on preference for PCB flour at 1 percent significance level. In depth probing revealed that consumers mostly combine PCB flour with other flours to make children's porridge and stiff porridge (*Ugali*). These results are at odds with those of Katunzi-Kilewela *et al*. (2022), who found that colour played a significant positive role in consumers' preferences for porridge compositions. The study by Katunzi-Kilewela *et al*. (2022) focused on a composite flour made of cassava and chia seeds, whereas this study focused on PCB flour, which may be the cause of the discrepancy in these results.

Shelf life was found to have a significant positive influence on PCB flour at 5% significance level. An increase in shelf-life increases the probability of choosing PCB flour by 0.6988 units, holding other variables constant. This implies that PCB flour has a longer shelf-life than the other products, and that households prefer products that can be stored for longer periods of time. The PCB flour has a six-month shelf life. In depth probing revealed that consumers are more inclined to purchase a product that has a long shelf life. These results corroborate those of Samotyja and Ankiel (2020) who found that consumers prefer foods with long shelf life.

4.3 Factors influencing consumption frequency for PCB products in Machakos County.

The goodness-of-fit of the four-count data models was compared and evaluated using the likelihood ratio test (LRT), the Vuong test, the ZIP option test, the Akaike information criterion (AIC), and the Bayesian information criteria (BIC). The Poisson model's deviation and Pearson goodness of fit was first calculated. Both categories of the goodness of fit were significant revealing that there was over dispersion of data (Appendix B). To evaluate the degree of over dispersion of data, the two categories of the goodness of fit were divided by degrees of freedom. The ratios were noticeably higher than one, which showed that the data was excessively distributed. As additional proof of over dispersion, the NBR model was performed, which demonstrated that there was over dispersion of data because alpha was greater than zero (Appendix E). NBR would have been a better fit model, as evidenced by the fact that its AIC and BIC results were much lower than those for Poisson (Appendix B). The zero-inflated model was then run. Significant results from the Z test for Vuong demonstrated that ZINB performs better than the NBR model in the underlying data-generating process, demonstrating that both perfect and imperfect states for excess zeros were certainly in operation. Because ZINB had a significant LR test alpha of zero, it was more accurate at fitting data than ZIP (Appendix F). ZINB was utilized in the current study to determine the factors influencing consumption frequency for PCB products (Table 4.5). Due to the heteroscedasticity issue with the data, the ZINB model was run with the robust option to provide robust standard errors.

Table 4.5: Results from Zero Inflated Negative Binomial results on consumption frequency for PCB products

Variables	Coeff	Std. Err
Age	0.0094**	0.0041
Gender	0.0595	0.0788
Education	0.0259**	0.0125
Household size	-0.1259**	0.0586
Child below five years	0.2544***	0.0845
Monthly income	0.0624	0.0525
Health status	0.1423*	0.0766
Employment	-0.2224***	0.0754
Substitute	0.0325	0.0737
Market distance	0.0133	0.0336
Price perception	0.0277	0.0795
Nutrition	0.3969*	0.2314
Cooking time	0.1549	0.0972
Fuel	-0.0227	0.1275
Water	-0.0626	0.0940
Taste	0.0951	0.0894
Colour	-0.3845**	0.1564
Constant	-0.0371	0.5457
Logistic regression for zero inflation		
Household size	- 0.3329***	0.1080
Monthly income	- 0.7665**	3.9230
Education	- 0.1177**	0.3274
Price perception	- 16.2841***	3.9230
Constant	10.6274***	3.1037
/lnalpha	- 3.0840***	0.6081
Alpha	0.0458	0.0278
Log pseudo likelihood= -580.9915, Wald chi2 (17) =69.91, Prob > chi2 = 0.0000		

*, ** and *** represent 10%, 5% and 1% significance levels, respectively

Table 4.5 illustrates the findings from the ZINB model for variables affecting PCB product consumption frequency. Moreover, the results of the NBR model captured in the first part of Table 4.5 indicate the variables that affect the likelihood of a household being in an imperfect state.

The study results showed that there is a significant positive relationship between the age of the decision maker and the consumption frequency of PCB products. This means that older respondents are more likely to consume PCB products frequently than their younger counterparts. Older people have different dietary needs than younger people. As people age, their bodies require different nutrients to maintain health, and PCB products may be a good source of these nutrients. According to Doma *et al.* (2019), older individuals are more conscious of the significance of beans as part of their diets to promote healthy ageing. The nutritional value of beans was found to be a crucial factor that the study found to be much more prevalent among older bean consumers. Similar findings were reported by Wuenstel *et al*. (2014), who found that adolescents between the ages of 13 and 18 had lower mean bean intake values and lower bean consumption frequencies.

Consumption frequency for PCB products was also significantly and positively influenced by the educational background of respondents. Individuals with more years of education were more likely to consume PCB products regularly than those with fewer years of education. Those with higher levels of education were more aware of the nutritional and health benefits of incorporating beans in their meals than persons with lower education levels, thus it was expected that they would choose healthier foods. Education helps people comprehend the nutritional information and health implications of food products. Additionally, people with higher education levels embrace new technologies more quickly than people with lower education levels, which may affect how well health interventions work (Raghupathi & Raghupathi, 2020). These findings are consistent with those of Fard *et al*. (2021), who established a positive relationship between healthier diet and educational attainment.

The size of the household had a negative influence on the consumption frequency of PCB products. This means that respondents from larger households are less likely to consume PCB products frequently than those from smaller households. Larger households have more diverse dietary needs and preferences, making it more difficult to find PCB products that everyone likes. Additionally, larger households may have more people to feed, making it more expensive to purchase PCB products. These findings are in support for those of Aseete *et al*. (2018), who

reported that PCB enthusiasts had small households and that there was a significant inverse association between PCB product consumption frequency and household size.

The frequency with which PCB products were consumed was significantly and positively influenced by the presence of children under the age of five in a household. This means that households with young children are more likely to consume processed bean products frequently than those without young children. Children below the age of five have different dietary needs than adults and may require more protein in their diets. The PCB products are often used as a quick and easy source of protein in meals, and parents may be more likely to use them for this purpose. In addition, young children are often picky eaters and may be more likely to eat PCB products than other types of protein. Further, PCB products are often less expensive than other sources of protein, which may make them more appealing to families with young children. Thus, by including PCB products in meals, parents may provide their children and other family members with a balanced diet. Saito *et al*. (2018) reported that having small children at home affected how frequently Japanese married women consumed several minerals and macronutrients. These results corroborate those of Nambiar and Florkowski (2013), who found that having children at home has a significant positive effect on how frequently people in Uganda consume peanut butter paste with other foods.

It was also established that the health of a household had a positive and significant impact on how frequently PCB products were consumed. A household with a high proportion of household members living with a medical condition was found to regularly consume PCB products. Beans are a significant protein source and are high in various crucial minerals, including potassium, magnesium, folate, iron, and zinc (Messina, 2014). Furthermore, according to Messina (2014), consuming beans can reduce low-density lipoprotein cholesterol levels, improve metabolic syndrome risk factors, and reduce the likelihood of developing diabetes and ischemic heart disease. These findings are in line with those of Henn *et al*. (2022), who found that the benefits of pulses for health are one of the key factors driving consumption frequencies in the five European countries investigated.

It was found that a household decision maker who was employed significantly and negatively influenced how regularly a household consumed PCB products. Employed people may have higher incomes than unemployed people and may be able to afford more expensive and diverse sources of protein, such as meat, fish, eggs, or dairy products. They may also perceive PCB

products as less desirable or appealing than these alternatives. Additionally, consumers revealed that PCB products were not available in all the nearby food outlets. Furthermore, according to Caswell and Yaktine (2013), persons who work in formal jobs frequently obtain food in methods that are suboptimal for maintaining a balanced diet, such as skipping meals, ordering takeout, and dining out. In other words, households with a decision-maker who is employed have a higher likelihood of using PCB products less frequently on average each month. These findings conflict with those of Blekking *et al*. (2020), who found that households with informal employment had lower food consumption frequencies. The discrepancy in results can be attributed to the fact that the current study concentrated on the frequency of PCB products use in the rural areas in Kenya while Blekking *et al*. (2020) concentrated on urban food security in Zambia.

Having nutrition information on PCB products was found to have a significant and positive impact on consumption frequency for these products. The PCB products are a good source of protein, carbohydrates, and minerals, hence, will be used more frequently by consumers who are aware of their nutrition benefits than by consumers who are unaware. According to Gambaro *et al*. (2011), nutrition awareness favoured the frequency of consumption of fruits, vegetables, and low-fat items, thus supporting this study's findings.

The study found that the colour of PCB products had a significant negative influence on the consumption frequency for these products. Consumers may have negative associations with certain colours of processed bean products, such as brown or black, which may indicate poor quality, staleness, or contamination (Pathare *et al.*, 2013). Alternatively, consumers may prefer brighter colours that suggest freshness**,** nutritional value, or appealing flavour. Similarly, Winham *et al*. (2019) established that respondents chose the type of dry bean to consume based on the colour of beans, which affected how frequently they consumed bean meals.

The second section of Table 4.5 shows the results of the logistic regression which show factors that influence the likelihood that a household will be in a perfect state. Household size was found to have a significant negative effect on the likelihood of a count being zero for PCB product consumption frequency, indicating that as household size increases, the probability of observing a zero count decreases. It is expected that a large household would spend more on a prepared PCB meal, thus, to lower this cost, households will go for cheaper options such as consuming the common beans in place of PCB products. Hence, a large household was probably a true non-consumer of PCB products. Small households are more likely to consume PCB products, which

reduces the possibility that a count is truly zero. Additionally, it was established that monthly income had a significant negative influence on the likelihood of a count being zero for consumption frequency for PCB products, indicating that as monthly income increases, the probability of observing a count being zero decreases. High-income households were more likely to consume PCB products, decreasing the possibility that a count is truly zero.

Education level was found to significantly and negatively influence the likelihood of a count being zero for consumption frequency for PCB products. Higher educated households are more likely to consume PCB products because they are more likely to be aware of their nutritional advantages, which decreases the likelihood that a count is a true zero. Gido *et al*. (2017) reported a correlation between education level and a decreased probability of a count for leafy African Indigenous Vegetables (AIVs) consumption Level being zero. Finally, the likelihood that the count of consumption frequency is a true zero was significantly influenced negatively by the price perception of PCB products. A true zero count for the frequency of consumption of PCB products is less possible if respondents believe that these products are affordable since they are more inclined to use them.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

i. Based on the results of the study, it can be concluded that there is a significant level of awareness among households in Machakos County regarding PCB products. However, there is still room for improvement in terms of awareness of specific products, particularly bean noodles.

ii. As expected, the preference of PCB products is influenced by various factors such as household size, cooking time, fuel, employment, monthly income, health status, shelf-life, and colour. Larger households and consumers who value time and fuel savings prefer packed beans over other products, while consumers who have higher income, better health, and longer storage needs prefer PCB flour, PCB snack, and PCB noodles. The negative effect of colour on the choice of PCB flour suggests that consumers dislike the colour of PCB flour compared to packed beans. These findings can be useful for policymakers, marketers, and producers who want to understand the factors that influence consumer preferences and make informed decisions about product development, pricing, promotion, and distribution strategies.

iii. Knowledge of the nutrition composition of PCB products, education level, presence of children below five years in a household, and health status of the household are factors that positively affect the regular consumption of PCB products. This is because PCB products are a healthy food choice for individuals with medical conditions and children require protein and various vitamins and minerals for development and growth which they can reap from regular intake of these bean products. However, the study also found that regular consumption of PCB products is negatively affected by household size, probably due to the costs associated with meal preparation made from these products. In addition, colour negatively impacts regular consumption of PCB products. Surprisingly, employment status of the household head also negatively affects regular consumption of PCB products, likely because of limited time to balance between work and other household tasks.

5.2. Recommendations

In the pursuit of improved food and nutrition security, this study provides critical information to policymakers and other stakeholders. To attain improved food and nutrition security, there is a need to develop policies and strategies that encourage the use of PCB products. Therefore, this study recommends that;

i. The promotion and marketing efforts for these products should continue to prioritize the promotion of packed beans due to their higher awareness among consumers. Additionally, leveraging social networks and peer influence can be an effective strategy for increasing awareness and knowledge about other PCB products such as bean snacks, bean flour, and bean noodles.

ii. The policymakers, marketers, and producers should emphasize the nutritional value and health benefits of PCB products, such as high protein, fiber, and vitamin content, to appeal to health-conscious consumers. Additionally, they need to improve the appearance of PCB flour by using natural or artificial food colouring agents that are safe, appealing, and affordable, to enhance its marketability.

iii. This study also recommends that there is need to emphasize on the convenience and quality of PCB products to boost consumption frequency. There is need to highlight the ease and speed of cooking, the nutritional value, the sensory attributes, and the cultural significance of these products to attract consumers who value their time, health, and taste. In addition, there is need to invest in research and development to improve the quality, variety, and affordability of these products, which can enhance their marketability and competitiveness.

5.3 Further Research

This study proposes the following areas for further research;

i. To determine consumer perceptions towards PCB products.

ii. A comparative analysis between PCB products and the common dry beans.

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APPENDICES

Appendix A: Questionnaire
HOUSEHOLD LEVEL SURVEY QUESTIONNAIRE

I am **Judy Gatwiri Mutegi**, pursuing a Master of Science in Agricultural and Applied Economics at Egerton University. I am carrying out a study on **awareness and consumption patterns for precooked bean products among households in Machakos town sub county, Kenya**. This study is for academic purposes and aims to understand consumer awareness and consumption patterns for precooked bean products at the household level. The questionnaire focuses on the data that is collected directly from the household head or spouse.

CONSENT.

Decision to participate in this study is voluntary and if at one point you wish to withdraw, we will completely respect your right to do so. The information you provide will be treated with strict confidentiality and will be analyzed jointly with others. Please write your name and sign if you voluntarily agree to participate in this interview. Your participation is highly appreciated. Thank you.

Do you wish to participate in this study?

- Yes
- No

Signature……. Date……...

Name of respondent …….

Signature……. Date……...

Name of enumerator……...

SECTION A: GENERAL INFORMATION

PROFILE

Sub-county	
Ward	
Village	

SECTION B: HOUSEHOLDS' SOCIO-ECONOMIC CHARACTERISTICS

1. Age of the respondent	……Years
2. Gender of the respondent	1= Female 0=Male
3. Are you the one who makes household consumption decisions?	1=Yes, 0= No
4. If no, what is your relationship to the decision maker?	…….
5. How many years of formal education do you have?	……..
6. What is your household type?	o Male and female-headed o Female-headed o Male-headed
7. No. of household members/dependents	……..
8. How many members of your household are below 5 years?	……
9. What is your occupation?	…….

10. Do you belong to any social group?
    - o Yes
    - o No
11. Does any member of your household has any underlying health condition?
    - o Yes
    - o No

12. If yes, how many members of your household have any underlying health condition? ……

13. Where do you often do your household shopping?

Tick where appropriate	*Response*
Supermarket	
Wholesale and retail store	
Kiosk	
Other *Specify*	…….

SECTION C: PRECOOKED BEAN PRODUCTS INFORMATION

1. What is the distance from your place of residence to the market? ……Kms
2. Do you consume dry beans or any bean products?
    - Yes
    - No
3. Are you aware of the nutrition composition of beans?
    - Yes
    - No
4. If yes, how would you range your level of nutrition knowledge on beans?

Likert scale	**Poor**	**Fair**	**Average**	**Good**	**Excellent**
Measurement	**1**	**2**	**3**	**4**	**5**
Knowledge level on the nutrition of Precooked bean products					

5. Are you able to identify the nutrition composition of beans?
    - Yes
    - No
6. What other proteins do you consume?.....
7. Do you consume meat and meat products?
    - Yes
    - No
8. Do you consume precooked bean products?

- Yes
- No

9. Are you aware of the existence of precooked bean products?
    - Yes
    - No
10. If no, would you be interested in knowing more about the products?
    - Yes
    - No
11. What kind of information would you like to get?

Tick where appropriate	*Multiple Response*
a) Types of precooked bean products	
b) How to prepare precooked bean products	
c) Where to source precooked bean products	
d) Importance of consuming precooked bean products	

12. If yes, which precooked bean product are you aware of?

Tick where appropriate	*Multiple Responses*
a) Packed PCB	
b) precooked bean flour	
c) precooked bean snack	
d) precooked bean noodle	

13. Where did you obtain the information on precooked bean products from?

Tick where appropriate	*Multiple Response*
a) Radio	
b) Television	
c) Internet	
d) Processor	
e) Friends	
f) Supermarket display	
g) NGO	
h) Government agency	

i) Other *Specify*	

14. What kind of information did you get?

Tick where appropriate	*Multiple Response*
e) Types of precooked bean products	
f) How to prepare precooked bean products	
g) Where to source precooked bean products	
h) Importance of consuming precooked bean products	

15. Which precooked bean product do you consume?

Tick where appropriate	*Multiple Responses*
a) Packed PCB	
b) precooked bean flour	
c) precooked bean snack	
d) precooked bean noodle	

16. Are you aware of the benefits associated with consuming precooked bean products?
    - Yes
    - No
17. If yes, how would you range your level of awareness of the benefits associated with consuming precooked bean products?

Likert scale	**Poor**	**Fair**	**Average**	**Good**	**Excellent**
Measurement	**1**	**2**	**3**	**4**	**5**
Benefits associated with consuming precooked bean products					

18. Below is a table with benefits associated with consuming precooked bean products, please select the ones that you are aware to be associated with these products.

Tick where appropriate	*Multiple responses*
Precooked bean products are nutritious	
Consumption of precooked bean products help conserve the environment	
Precooked bean products are energy efficient	

Precooked bean products require less water for cooking	
Precooked bean products take less time to prepare	
Precooked bean products require less labor during preparation	

19. Does information on the nutrition composition of precooked bean products influence your preference for these products?
    - Yes
    - No

20. What prompts you to buy precooked bean products?

Tick where appropriate	*Multiple Responses*
a) Precooked bean products are cost-saving	
b) Precooked bean products are nutritious	
c) Precooked bean products are energy efficient	
d) Precooked bean products solve the problem of water shortages	
e) Precooked bean products solve the problem of wood availability	

21. Does any member of your household have an underlying health condition that influences your preference for precooked bean products?
    - Yes
    - No

22. How much do you pay for a kilo of precooked bean products in Kshs?

Tick where appropriate	*Multiple Responses*
e) Packed PCB	
f) precooked bean flour	
g) precooked bean snack	
h) precooked bean noodle	

23. Does consumption of meat or dry beans influence your preference for precooked bean products?
    - Yes
    - No

24. How much time do you take to prepare a meal of precooked bean products?

…….. Minutes

25. Does the cooking time of precooked bean products influence your preference for these products?
    - Yes
    - No
26. How much water do you use to prepare a meal of precooked bean products?

    ……. litres
27. Does the amount of water used to prepare a meal of precooked bean products influence your preference for these products?
    - Yes
    - No
28. What type of cooking fuel do you use to prepare a meal of precooked bean products?

    ……
29. How many units of fuel do you use to prepare a meal of precooked bean products?

    ……
30. Does the amount of fuel used to prepare a meal of precooked bean products influence your preference for these products?
    - Yes
    - No
31. How many times do you consume precooked bean products in a month?

    …….
32. What is your frequency for consuming precooked bean products?

Tick where appropriate	*Response*
a) Daily	
b) Weekly	
c) Monthly	

33. Which type of precooked bean product do you mostly consume?

Tick where appropriate	*Multiple Response*
i) Packed PCB	
j) precooked bean flour	

k) precooked bean snack	
l) precooked bean noodle	

34. Over the last one month, how many kgs of precooked bean products have you purchased?

Tick where appropriate	*Multiple Response*
a) PCB	
b) precooked bean flour	
c) precooked bean snack	
d) precooked bean noodle	

35. Does knowledge on nutrition composition of precooked bean products influence your consumption frequency for these products?
    - Yes
    - No
36. Does any member of your household have an underlying condition that requires you to consume precooked bean products often?
    - Yes
    - No

37. What is your main source of income?	1=employment 2=small scale business 3= farming 4=casual jobs
38. What is the frequency of payment?	1=daily 2=weekly 3=monthly

39. If in employment, how much do you earn in a month?.....Kshs
40. If in business, how much profit do you make in a day?.....Kshs
41. If in farming, how much profit do you make in a month?.....Kshs
42. What is your annual average income? ……..Kshs
43. Does consumption of meat or dry beans influence your consumption frequency for precooked bean products?
    - Yes
    - No
44. Does the price of precooked bean products influence your consumption frequency for these products?

- Yes
- No

45. Does distance to point of purchase of precooked bean products influence your consumption frequency for these products?
    - Yes
    - No
46. Does the cooking time of precooked bean products influence your consumption frequency for these products?
    - Yes
    - No
47. Does the amount of water used to prepare a meal of precooked bean products influence your consumption frequency for these products?
    - Yes
    - No
48. Does the amount of fuel used to prepare a meal of precooked bean products influence your consumption frequency for these products?
    - Yes
    - No
49. Does the taste of precooked bean products influence your consumption frequency for these products?
    - Yes
    - No
50. Does the colour of precooked bean products influence your consumption frequency for these products?
    - Yes
    - No
51. Does the shelf life of precooked bean products influence your consumption frequency for these products?
    - Yes
    - No

Appendix B: Deviance and Pearson Goodness of Fit

Deviance goodness-of-fit	670.8677
	Prob > chi2(367) = 0.0000
Pearson goodness-of-fit	735.9151
	Prob > chi2(367) = 0.0000

Appendix C: Akaike's Information Criterion and Bayesian Information Criterion

Model	**N**	**ll(null)**	**ll(model)**	**df**	**AIC**	**BIC**
Poisson	385	-1250.435	- 673.6973	18	1383.395	1454.553
NBR	385	-816.9911	-618.5303	17	1271.061	1338.266

Appendix D: Poisson Model Results on Consumption Frequency for PCB Products

Variables	Coeff	Std. Err
Age	0.0010***	0.0034
Gender	0.1372**	0.0628
Education	0.0301**	0.0131
Household size	- 0.1967***	0.0361
Child_5years	0.3765***	0.0493
Monthly income	0.1127**	0.0512
Health status	0.0265	0.0815
Employment	- 0.1791**	0.0696
Substitute	- 0.0100	0.0638
Market distance	- 0.0004	0.0277
Price perception	0.1349*	0.0702
Nutrition	1.4137***	0.1275
Cooking time	0.3261***	0.0809
Fuel	0.2505***	0.0833
Water	0.1620**	0.0682
Taste	0.2243***	0.0746
Colour	- 0.2009	0.1818
Constant	- 2.1437***	0.5258
Log likelihood = -652.7743, LR Chi2 (17) =1195.32, Prob>chi2 = 0.0000, Pseudo R2=0.4780		

*, ** and *** represents 10%, 5% and 1% significance levels, respectively

Appendix E: NBR Results on Consumption Frequency for PCB Products

Variables	Coeff	Std. Err
Age	0.0082	0.0068
Gender	0.1533	0.1147
Education	0 .0236	0.0182
Household size	- 0.2489***	0.0542
Child below 5 years	0.4729***	0.0820
Monthly income	0.1415*	0.0731
Health status	0.0478	0.1316
Employment	- 0.1948*	0.1227
Substitute	- 0.0527	0.1167
Market distance	0.0138	0.0569
Price perception	0.2482*	0.1326
Nutrition	1.2750***	0.2451
Cooking time	0.4973***	0.1641
Fuel	0.4105***	0.1448
Water	0.3173***	0.1215
Taste	0.3560**	0.1663
Colour	- 0.1791	0.2194
Constant	- 2.4942***	0.8037
/lnalpha	-1.1622	0.2631
Alpha	0.3128	0.0823
Log likelihood= -613.2589, Wald chi2 (17) = 461.68, Prob > chi2 =0.0000, Pseudo R2 = 0.2494.		

*, ** and *** represents 10%, 5% and 1% significance levels, respectively

Appendix F: Results From ZIP Model on Consumption Frequency For PCB Products

Variables	Coeff	Std. Err
Age	0.0096***	0.0034
Gender	0.0607	0.0646
Education	0.0257*	0.0132
Household size	-0.1074***	0.0401
Child below 5 years	0.2279***	0.0551
Monthly income	0.0667	0.0516
Health status	0.1305*	0.0673
Employment	- 0.2229***	0.0696
Substitute	0.0453	0.0677
Market distance	0.0127	0.0278
Price perception	0.0207	0.0672
Nutrition	0.2955**	0.1294
Cooking time	0.1224	0.0773
Fuel	-0.0499	0.0811
Water	-0.0910	0.0684
Taste	0.0853	0.0708
Colour	-0.3837**	0.1810
Constant	0.0545	0.5530
Logistic regression for zero inflation		
Household size	- 0.3219***	0.0956
Monthly income	- 0.7513***	0.2567
Education	- 0.1185**	0.0523
Price perception	- 5.6423***	2.0565
Constant	10.5285***	2.4485
Vuong test z=2.54, Pr > z= 0.0055		
Log likelihood = -583.8454, LR chi2 (17) = 86.83, Prob > chi2 = 0.0000		

*, ** and *** represents 10%, 5% and 1% significance levels, respectively

Appendix G: Precooked Bean Products

Packed beans

PCB flour

PCB noodles

PCB snack

Appendix H: NACOSTI Permit

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FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Consumption frequency for precooked bean products among households in Machakos County, Kenya

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Additional information is available at the end of the article

Abstract: Processed beans are rich in nutrients and aid in improving household diets as they contain nutritional elements like protein, dietary fibre, and minerals while saving time and money. However, the consumption frequency for processed beans is still low among households in Machakos County. This study aims to determine the factors influencing consumption frequency for precooked bean products in Machakos County, Kenya. A sample of 385 respondents was obtained using a multistage sampling procedure. Results from the zero-inflated negative binomial regression model revealed that age, presence of children under 5 years in the household, household health, and nutrition knowledge significantly and positively influenced the frequency of consumption of precooked bean products. Further, the results revealed that the frequency of consumption of precooked bean products was significantly and negatively influenced by household size and employment status as well as the colour of these bean products. Given the positive and significant influences of nutrition knowledge on consumption frequency, an emphasis on the economic and health benefits of precooked bean products is needed to increase the consumption frequency for these products. Additionally, investing in formal education could increase the consumption frequency for precooked bean products over time.

Subjects: Agriculture & Environmental Sciences; Sustainable Development; Economics