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# ACCEPTABILITY OF CEREAL-CRICKET COMPOSITE PORRIDGE AS INFLUENCED BY SOCIO-ECONOMIC FACTORS AND BREAST-FEEDING STATUS OF MOTHERS AND CARE-GIVERS IN SIAYA COUNTY, KENYA

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## ABSTRACT

The trajectory for widespread integration of edible insects into the human diet is still confronted by low acceptability especially among communities that traditionally or habitually do not consume insects. While the concern today is how best to present edible insects into food matrices that improve their acceptability, this development should be aligned with consumer intrigues into the choices of insect-based foods. This study determined the influence of socio-economic factors (age, education, marital status, occupation, and income levels), and breastfeeding status of mothers and care givers on acceptability of cricket-based porridges. Four composite porridge flours were developed by blending cricket flour with maize, wheat, and soy flour at four different levels. The reference formula (CP) had 0% cricket inclusion and was a composite of maize, wheat, and defatted soy flour in the ratio of 2:1:1 resembling Famila Baby weaning porridge flour, a common infant formula in Kenya. The other treatment flours were formulated by replacing an equivalent amount of soy flour with cricket flour at 25%, 50% and 75% to allow enrichment of Famila formula with cricket flour, and were coded as CPB1, CPB2 and CPB3, respectively. Porridge prepared from the flours were evaluated for acceptability among forty mothers and care-givers selected in Siaya County, Kenya. Non-cricket porridge was the most accepted across the respondents' socio-economic dynamics. Acceptability of cricket-based porridges improved with age and level of education but reduced significantly for both married ($p<0.000$) and unmarried women ($p<0.000$). Women engaged in formal employment rated cricket-based porridges significantly higher ($p<0.003$) than other occupations. Income level generated mixed influences with non-cricket porridge still rated significantly higher ($p<0.000$) than cricket-based porridges across different income groups. Breastfeeding had insignificant influence on acceptability of the porridges ($p=0.06$). From this study, age, education, occupation and income showed varied influences on the acceptability of cereal-cricket porridges and should therefore be considered among key factors that shape consumer acceptability. Consequently, promotion strategies should consider the latter socio-economic factors in devising interventions to improve acceptability of edible insects and their products.

**Key words:** Edible insects, Crickets, Porridge, Socio-economic status, Consumer evaluation, Acceptability

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## INTRODUCTION

Crickets among other edible insects continue to attract the attention of many researchers, policy makers and funding agencies on the need to integrate them into the global food systems due to their nutritional, economic and environmental benefits [1, 2]. Crickets can be easily reared in masses with locally available feed resources, and with low requirement for land and water [3, 4]. More importantly, they can supply significant amount of quality protein into the human diet ranging from 50 -70% depending on their feeding and growth environment [1]. Notwithstanding their potential for dietary transformation and farm enterprise profitability, their acceptability is still low [5-7]. Different promotion strategies employed in sub-Saharan Africa including training, dietary education and product development have not prompted significant increase in their consumption [8]. Apparently, food neophobia created by their unknown long-term health effects, cultural beliefs and changing lifestyle has created negative attitude towards insects' consumption, and remains the current biggest challenge to be addressed [5-7].

Food neophobia is suggested to be overcome by conferring trust in the social actors within the food value chain [9, 10]. However, in the present times, consumers' trust and confidence in the general market have reduced making it quite difficult for insect farmers, marketers, and other promoters to dissuade consumers from their negative attitude on some edible insects. Moreover, information dissemination on edible insects as a sustainable and nutritious food source has not impactfully penetrated remote and rural areas where majority of hungry and undernourished population are concentrated [11]. According to Brennan [12], awareness about a novel technology is important to induce curiosity and propensity, whereas insufficient familiarity is a precursor for consumer reticence to accept new foods [13, 14]. Latest interventions have seen edible insects fronted as nutritious and healthy foods through intensive sensitization in various platforms including media, journal publications and institutional outreach platforms. Still with these efforts, an impactful surge in insects' consumption to a level that can be quantified and be attributed to a reduction in hunger and malnutrition in sub-Saharan Africa is yet to be witnessed. It is now evident that low acceptability of edible insects could be associated with consumer inherent behaviors and other factors influencing their choices. This observation suggests the need for broad evaluation and understanding of their role in acceptance or rejection of edible insects.

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Ordinarily, consumer behaviors are known to be complex and shaped by both intrinsic and extrinsic factors. Consequently, food acceptability or rejection normally depends on whether it corresponds to consumer needs and expectations and is always a function of multi-dimensional factors or stimuli [15]. This makes food acceptability a variable and dynamic concept among different groups of individuals, and in different time periods and contexts. Although sensory attributes are regarded as key factors in food acceptability, other factors like individual chemical stimuli and psychological conditions influence food choices [15]. Besides, food preferences can be constrained by many other circumstances that are social and economic in nature [16]. In contemporary markets, consumer choices are always inclined towards foods which satisfy their needs in terms of enjoyment and which conform to their socio-cultural and economic alignments. For instance, consumer beliefs about a food product are reported to influence acceptability [17]. Similarly, the success of food products in the market usually follows diffusion of their knowledge to the customers. Knowledge about product composition, physico-chemical properties and in some instances processing methods influence acceptability [18]. Studies also show clear differences in social classes in terms of food choices and intake. For instance, Savy *et al.* [19] assert that dietary diversity is closely aligned with socio-economic status where individuals drawn from disadvantaged socio-economic backgrounds rarely purchase grocery foods, which are often considered more nutritious and healthier. Still with increased disposable income, consumption of diverse and healthy diets is not usually guaranteed as consumers may avoid certain foods for different reasons. Time availability also influences dietary choices and it is strongly associated with individuals' occupation [20]. Age is another important factor that comes with experience and responsibilities that often shape food choices [8].

To understand consumer choices in relation to edible insects and their products, there is need to understand unique characteristics that influence their food choices. This will help to contextualize selection behaviors and inform development of targeted strategies for improved acceptability. Previous studies have reported some socio-economic characteristics such as gender, education, income levels and training to shape adoption of cricket farming [21]. Some of these factors could play a role in consumer acceptability of cricket-based foods. The present study assessed how selected socio-economic factors and breast-feeding status of mothers and care-givers affect acceptability of cereal- cricket composite porridge. The study is an extension of prelude studies by Aboge *et al.* [22] that characterized the physico-chemical properties of cereal-cricket composite flours and Aboge *et al.* [8] that assessed sensory evaluation of cereal-cricket porridges.

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## MATERIALS AND METHODS

### Materials and preparation

Ingredients for the porridge were maize grains (*Zea mays*), soybean (*Glycine max*), wheat flour (*Triticum aestivum*) (Tropicana Wheat Flour, United Millers, certified by Kenya Bureau of Standards (KEBS)) and mature house crickets (*Acheta domesticus*) of 11 weeks old. Maize and soybean grains were bought from a local grocery, sorted, and milled. Soybean grains were first defatted in an oven at 180$^{o}$C for 2 minutes to deactivate anti-nutrients and improve the flour's flavor [23]. The defatted grains were milled separately and sieved through a 250 $\mu$m mesh to fine flours. The crickets were frozen at -20 °C, blanched at 98 $^{o}$C for a minute, oven dried at 50$^{o}$C for 72 hours, milled and sieved to fine flour. The independent maize, wheat, soybean, and cricket flours were packed separately and stored at room temperature for use in making the treatment formulae.

### Composite Flour formula

Four composite flours were formulated from maize, wheat, soybean flour in the ratio of 2:1:1, respectively but differing in cricket flour inclusion levels achieved by substituting soy flour with an equivalent amount of cricket flour at 0%, 25%, 50% and 75% (Table 1). The four formulated composite flours were labelled as CP, CPB1, CPB2 and CPB3 respectively. Reference formula was Famila baby weaning porridge flour (Famila Nature Food, Baby Weaning Porridge Mix, UNGA limited) which is a composite of maize, wheat, soy flour in the ratio 2.1.1, respectively. The infant formula was chosen due to its popularity and wide usage for child feeding in Kenya. The formula meets the WHO recommendation of 3:1 for carbohydrates to protein requirement in baby formula [24].

### Nutritional composition of the flours

The flours were analyzed for proximate composition (moisture, ash, fibre, protein, fat, and carbohydrate) and mineral content (potassium, calcium, sodium, iron, phosphorus, magnesium, and zinc). Moisture content was determined by drying method, ash by incinerating in a muffle furnace at 550 °C, protein determined according to Semi-kjedahl method, fat by Soxhlet extraction method, dietary fibre by enzymatic gravimetric method—Prosky (AOAC 1996). Carbohydrate value was calculated as the difference between 100 and the sum of the percentages of moisture, protein, fat, ash and dietary fibre. The minerals were determined by flame Atomic Absorption Spectrometry (AAS).

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## Porridge preparation

Each flour was used to make porridge by mixing 250g of the flour in 4-litres of water then boiled and left to simmer for 15 minutes. The porridges were allowed to cool to $60^0$C and kept in thermo flasks labelled with the corresponding codes for the flours for consumer test.

## Selection of study participants

Women who participated in this study were identified in a two-stage sampling technique that started with purposive selection of women with children under the age of 5 years in Karapul Sub-location in Siaya County, Kenya. This was followed by random selection of 40 women (mothers and caregivers) to participate in the evaluation. This sample size met the 40-threshold required for consumer test and descriptive analysis. Karapul Sub-Location was selected because it is traditionally known for edible insect consumption, and it is also part of the Alego Usonga Sub-County that has received more insect promotion supports such as sensitization, farmers training and incentives. Mothers and care-givers were specifically selected because of their important role in child feeding and their acceptability the cricket-cereal porridge would be key in feeding the same to their infants. Their socio-demographic data on age, marital status, education level, occupation, income level and breast-feeding status were recorded. Later, the influence of these socio-demographic characteristics and breast-feeding status on overall acceptability of the porridges were determined.

## Sensory analysis of the porridges

The women were trained on the 9- point hedonic rating scale (from “9” – like extremely to “1” - dislike extremely) according to Villanueva *et al.* [29]. They were informed of the composition of the porridges and their nutrional and health benefits. Their partcipation was voluntary after consenting. The four porridges were presented to them at the same time in a single-blinded approach and they were allowed to assess and give scores for sensory attributes (colour, texture, aroma, taste and mouth-feel) and the overall acceptability of the porridges.

## Data Analysis

Data was summarized into means and standard deviations (SD). One-way analysis of variance (ANOVA) was performed to deterimine the influence of socio-economic characteristics on acceptability of the porridges at $p \leq 0.05$. Tukey’s studentized range test was used to compare the means to identify statistically homogeneous subsets at $\alpha=0.05$.

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## Ethical Considerations

The study protocol was approved by Jaramogi Oginga Odinga University of Science and Technology (JOOUST) Ethics Review Committee with approval number: ERC/23/6/20-1 and National Commission for Science, Technology, and Innovation (NACOSTI) with approval number:347723. Informed consents were obtained from the participants prior to their participation in the study.

# RESULTS AND DISCUSSION

## Nutritional composition of the flours

Protein, fibre, fat, potassium, sodium, magnesium, and zinc contents of the flours improved significantly on addition of cricket flour (Tables 2 and 3). A different observation was made for carbohydrate, calcium, phosphorus, and iron which reduced on addition of cricket flour. Overall, CPB3 (flour with the highest cricket level) recorded the highest protein, fiber, fat, potassium, sodium, magnesium and zinc. The other three flours with 0%, 25%, 50% substitution levels reported significant amount of nutrients that can still contribute to addressing protein-energy malnutrition and mineral deficiencies in children (Tables 2 and 3). The protein content of flour CPB2 (50% substitution) and CPB3 (75% substitution) were slightly below the recommended 25 g/100g per day requirement for child feeding. But still, protein content of all the flours met the 10g/100g required for edible parts of food to be considered rich in protein [24]. Concurrent with the present study, improved protein, fat, and mineral contents of foods enriched with edible insects have been reported [25-27]. Cereal-cricket composite flours developed in this study demonstrated nutritional potential and can be used for weaning. The same porridges can be part of nutrition-sensitive interventions targeting nutritionally vulnerable groups to improve their nutritional health.

## General sensory evaluation of the porridges

Without considering their socio-demographic characteristics, the women rated the four porridges on a nine-point hedonic scale as follows: CP (8.5 ± 0.728), CPB1 (7.08 ± 0.94), CPB2 (5.75 ± 1.53) and CPB3 (3.60 ± 1.95) (Table 4). Significant decrease in the rating of porridges with increased addition of cricket flour were observed for colour ($p<0.000$), taste ($p<0.000$), texture ($p<0.000$), aroma ($p<0.000$), mouth-feel ($p<0.000$) and overall acceptability ($p<0.000$). Non-cricket porridge was the most rated for sensory attributes and overall acceptability. For cricket-based porridges, CPB1 porridge developed with the lowest cricket flour inclusion was most preferred in sensory attributes, whereas CPB3 developed with the highest cricket-flour inclusion was the least accepted. The taste and aroma of cricket porridges were rated more than colour, texture and mouth-feel. This rating

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could have been positively influenced by defatting soybean which is reported to produce a characteristic sweet aroma and flavor [23]. Cricket flour on the other hand was noted to produce aroma close to nuts and a little like fish and this seemingly made cricket-enriched porridges less preferred.

Although the independent cricket flour was finely sieved before use, cricket-enriched porridges recorded the lowest ratings for texture and mouth-feel relative to other attributes. This low rating points to existing generic fiber in cricket flour which cannot be easily removed by sieving. Cricket flesh has a lot of fibre, and their body also covered with exoskeleton containing fibre in form of insoluble chitin [1]. Moreover, mature crickets of 10 weeks old assumed to have fully developed exoskeleton were used adding more fiber into the matrix. The mature crickets could not be avoided because this is the stage when they are reported to be rich in protein good for optimization in human diet [28]. However, the lower ratings for texture and mouth-feel observed for cricket-based porridges implies the need for finer grinding and sieving to reduce the effect of insoluble fibre on the two attributes.

**Socio-demographic characteristics and breast-feeding status of the women participants**

Analysis of socio-demographic characteristics of the participants showed the women were all in reproductive ages comprising of 25% teenagers (15-19 years), 27.5% young adults aged between 20-29 years, 22.5% middle aged women (30-39 years) and 25% older women aged (40-45years) (Table 5). Majority of them (78.5%) had attained post-primary education. Most of them (72.5%) were married and were assumed to be involved in household dietary selections. It was also important to understand the intrigues into the food choices by the unmarried women who were 27.5% including single mothers and care givers. In terms of occupation, most women were involved in informal employment such as: farming (32.5%) and small-scale business (25%), while 27.5% were students and only 25% were engaged in formal employment. The average monthly income for majority of the women (80%) was between US$ 50-100 while 20% earned below US$ 50. Income is known to determine the purchasing power and access to non-food items like healthcare, education and transport which are important proxy determinants of food security [11]. In terms of breastfeeding, only 40% of them were breastfeeding at the time of the study while 60% were not. Breastfeeding mothers are known to be keen to choose foods that improve their milk production for their babies during post-partum period [24]. Understanding how the two groups make their diet selections regarding insect-based food was important.

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**Overall acceptability of the porridges as influenced by age**

Overall acceptability of the porridges decreased significantly on addition of cricket flour among teenagers (15-19yrs) and young women (20-29yrs) (Table 6). Comparably, no significant differences were observed in the ratings of the four porridges among women aged 30-39 years and those in 40-45 years. Cricket-based porridges were least accepted by teenagers and young women. Their probable motivation for higher ratings of non-cricket porridge could be the positive feelings associated with it in terms of attractive sensory attributes. Apparently, these attributes became less attractive on addition of cricket flour reducing their liking for cricket-based porridges. Overall, cricket-based porridges with 25% and 50% substitution levels were still generally accepted by the two groups although with lower ratings compared to those aged 35yrs and above. Women who participated in this study were in their reproductive age and considering their natural responsibility of childbearing and nursing, their decisions on food choice and feeding practices during pre-natal and post-natal periods are important in determining their own health status and that of their infants [8]. Unlike teenagers and young women, the older women were not as keen on attractive sensory attributes but seemed to value the health benefits of cricket-based porridges informing their higher ratings for the latter. Moreover, the older women were mostly married with household-care responsibilities, thus keen on dietary choices that improve their own health and that of their family [8].

**Overall acceptability of the porridges as influenced by level of education**

Overall acceptability of cricket-cereal composite porridges improved with education level (Table 7). However, no significant differences were observed in the ratings of the four porridges among women with tertiary education ($p>0.05$). Still in this case, non-cricket porridge was the most accepted across all levels of education. Reduced acceptability of the porridges with addition of cricket-flour among those with primary and secondary education demonstrates their liking for non-cricket porridge more than cricket-based porridges, probably due to the same perceived attractive sensory attributes and their familiarity with the formula. Comparatively, those with tertiary education can be speculated to value nutritional and health benefits conferred by the crickets. According to Elena *et al.* [30], the level of one's education determines the knowledge and exposure which are important in decision making on food choices. Moreover, Hieke and Gruner [18] assert that consumers' skepticism for new technologies in food production is often ascribed to the lack of awareness of the technology and its advantage. Since most of women (78.5%) had attained post-primary education, they were assumed capable of making informed choices of the porridges presented to them. Further, education is known to build individuals' capacity for critical evaluation of matters and to aid in proper judgment.

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Lusk *et al.* [31] reports that knowledge about a product, especially its health benefits is an important factor in food preference and acceptability. Although the women were informed of the benefits of adding cricket flour into the formula, those with low level of education were still not very keen on the nutritional and health benefits of the cricket-based formula as a guide for their choices but instead opted for what satisfied their feelings and enjoyment. This selection behavior may disadvantage their infants who critically need nutritious food to support their active growth especially during their first 1000 days of life. According to Alderman and Headey [32], maternal education has a big impact on child nutrition as it determines the mothers'/care-givers' ability to choose and feed their children on safe, sufficient and nutritious foods for a better health outcome. The many cases of child malnutrition reported in sub-Saharan Africa have been largely linked to poor diets and feeding practices, resulting from poor dietary selection and limitation in resources [33]. In most cases, children's diets are composed of only energy-dense foods with low viscosity and high bulk making them even more difficult to consume, exacerbating undernutrition [34, 35]. This strongly suggests the need to emphasize maternal education on proper dietary selection especially during pre-natal and post-partum periods.

**Overall acceptability of the porridges as influenced by marital status**

No significant difference was observed in the overall acceptability of each of the four porridges between married and unmarried women ($p=0.057$) (Figure 1). However, a significant decrease in the overall acceptability of the porridges was observed on addition of cricket flour independently among married women and unmarried women. Although marriage was an insignificant factor in the acceptability of the porridges, slightly higher ratings for cricket-based porridge was noted among married women compared to their unmarried counterparts. Despite no similar studies reported in relation to insect-based foods, studies that have assessed the influence of marital status on food acceptability have yielded mixed findings. Concurrent with the present study, Deshmukh-Taskar *et al.* [36] observed that marital status did not have any influence on food choices. However, according to Irja *et al.* [37] and Wiig-Dammann *et al.* [38], married individuals tend to eat more healthy diets and are more concerned with foods that contribute to quality diets and which promote or protect their health and that of their families. Similarly, Davis and You [39], report marriage as a contributor to healthy living due to family responsibilities. In this study, it can be speculated that family care responsibilities imposed naturally on married women could have informed their slightly higher ratings for cricket-based porridges compared no unmarried women. Unmarried individuals in most cases may lack family care responsibilities or in some cases have lesser responsibilities and they can be assumed to make self-benefiting decisions on food choices which are largely based on convenience rather than

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healthy diets. Poor quality diets have been previously reported among single individuals who live and cook for themselves [37].

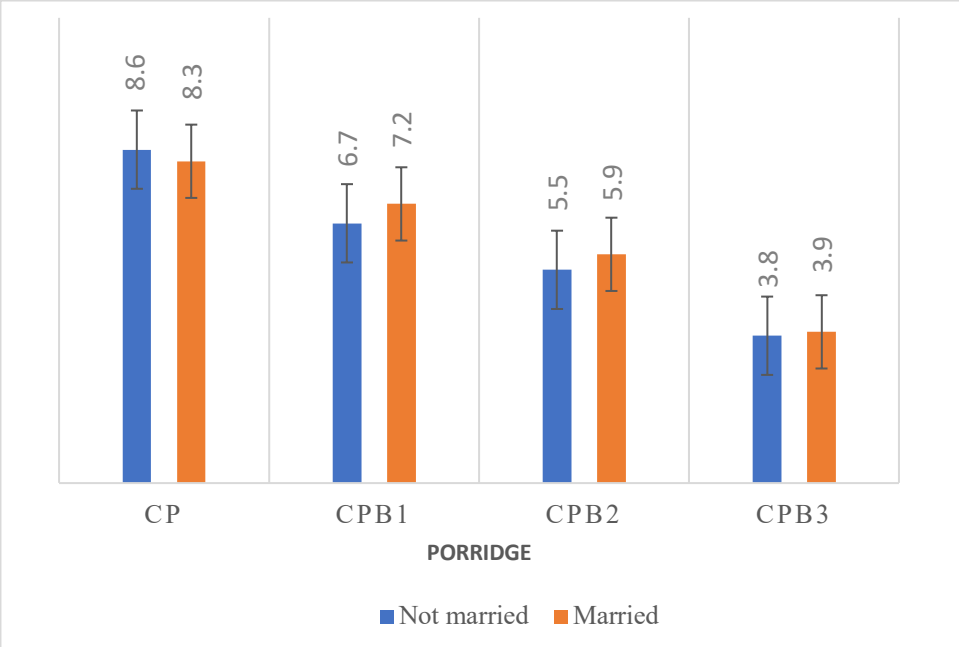


**Figure 1: Overall acceptability of the porridges based on marital status**

**Overall acceptability of the porridges as influenced by occupation**

Occupation yielded mixed influences on the overall acceptability of the porridges. Women with formal employment rated cricket-based porridges significantly higher than other occupations ($p=0.03$) (Figure 2). No significant differences were however, noted in the rating of the porridges by farmers and those in businesses ($p>0.05$). For students, the rating of the porridges reduced progressively and significantly with addition of cricket flour but still, non-cricket porridge was the most accepted across the different occupations. Students constituted of a few single mothers and those who were temporarily care givers in the absence of their parents. This group were mostly teenagers and young women whose choices like in the previous case were based on attractive sensory attributes which they perceived unattractive for the cricket-based porridges. Comparably, those in formal employment were mostly well educated (post-secondary education) and were able to prioritize cricket-enriched porridges because of their nutritional and health benefits. Further, this group can be assumed to be exposed to knowledge on quality diets through interactions at workplaces, trainings, seminars, and interaction with published materials on healthy eating habits. According to Wiig-Dammann *et al.* [38], consumption of healthy diets is a time-intensive process that requires enough time for planning, shopping and preparation of foods, and limited time for this process is a precursor for poor quality and unhealthy diets. Interestingly, women in formal employment and who in most cases can be

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assumed to be involved in long working hours rated cricket-based porridges better than other occupations indicating that time may not be a constraint towards insect-based diets. However, this should be considered in the context that the porridge were prepared and provided at their convenience and it would be interesting to know what happens when they must either rear crickets or shop for them and prepare them. For farmers and those involved in businesses, the ratings for the cricket-based porridges were inconsistent even though they rated cricket-based porridges higher compared to students. This group comprised mainly of married women with family-care responsibilities who are keen on healthy diets as reported by Irja *et al.* [37].

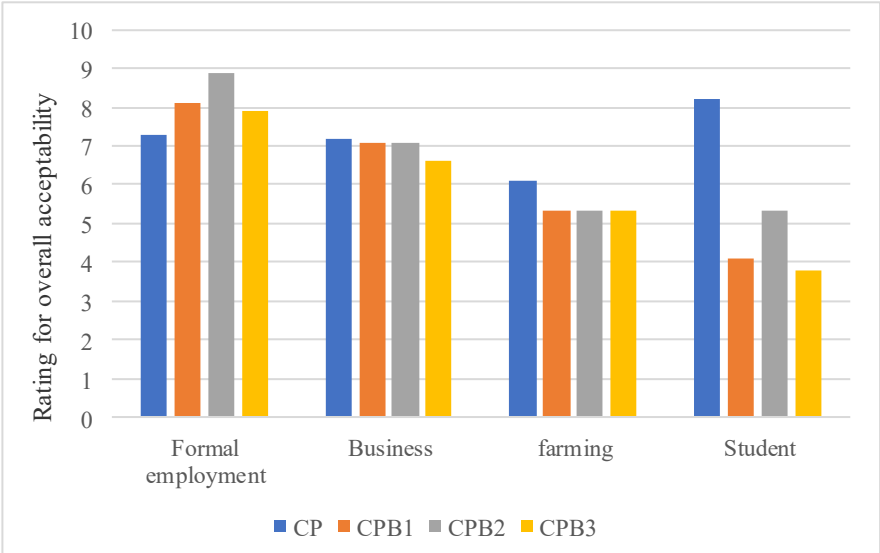


**Figure 2: Overall acceptability of the porridges by different occupations**

**Overall acceptability as influenced by income level**

Income level generated mixed influences and inconsistent trends on the overall acceptability of the porridges (Figure 3). Non-cricket porridge still remained most accepted and highly rated across different income levels. Porridge CPB3 (with highest cricket flour inclusion) was the least accepted across the income groups. Nonetheless, CPB2 and CPB3 were rated significantly higher among those with income level $200 and above. Most low-income earners were teenagers and young women who were observed to be under the care of their parents and guardians. Their porridge choices were still skewed towards attractive sensory attributes. However, those in the low-income group but not under any care might have been concerned with the likely cost of the cricket-based porridges. Since this was a new or unfamiliar diet, it is possible that they might have assumed that cricket porridge would be costly compared to their regular formula thus affecting acceptability. This choice behavior was similarly observed by Davis *et al.* [39]

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which noted that consumers associate quality foods with higher prices increasing the fear to change diets. On the contrary, a higher rating for cricket-based porridges was observed among women with higher income (above $200). From a general observation, this group consisted mainly of women engaged in formal employment, and who were more educated. They can be assumed to be more knowledgeable and have experience to make informed selection of more nutritious and healthy diets. Still, with the higher income compared to other groups, it can be assumed that they have enough money at their disposal to easily purchase quality foods. Previous studies have reported strong positive association between high income with positive attitudes and positive outcomes which are believed to inform selection and consumption of quality products [40, 41]. Similarly, Kamau *et al.* [42] reported a strong nexus between human nutrition and economic status since the latter determines physical and economic access to safe, sufficient, and nutritious foods. Insect-based cuisines provide quality diets in terms of nutritional and health benefits, and these positive outcomes can be perceived to be costly by low-income groups. However, according to Omar *et al.* [41] and Fotopoulos *et al.* [43] income only affects the quantity of healthy diets consumed and not their acceptability, further illustrating the mixed findings on the relationship between income and food acceptability. These inconsistent findings suggest the need for further investigations into consumers' willingness to pay for cricket-based porridges to be able to make conclusive reporting on the nexus between income and acceptability of cricket-based products.

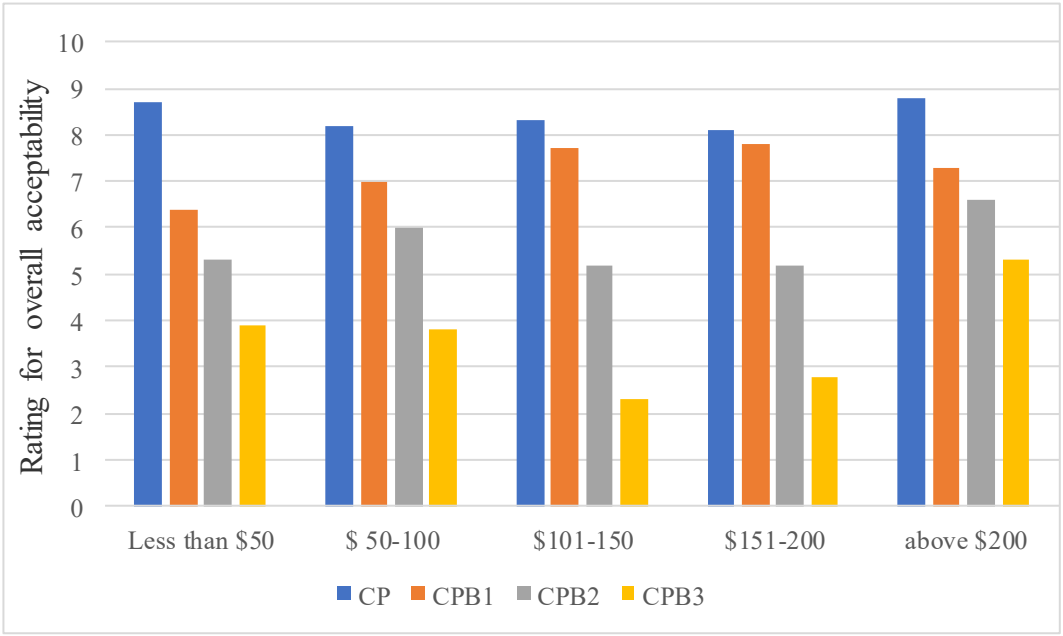


**Figure 3: Overall acceptability by different income groups**

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**Overall acceptability of the porridges by breastfeeding status**

No significant differences were observed in the overall acceptability of each of the four porridges between breastfeeding and non- breastfeeding women (Figure 4). Breastfeeding status was thus an insignificant factor in the acceptability of the cricket-based porridges. However, the overall acceptability of the porridges independently for breast-feeding women and non-breast-feeding women decreased significantly with addition of cricket flour ($p<0.05$). Proper child feeding demands that breastfeeding mothers produce enough breast milk for their infants, and this is always tied to mothers' diets. Similarly, nutritious and quality complementary foods are recommended for child feeding alongside breastmilk from seven months of age to enable them meet their nutrient demand [24]. However, mothers and care-givers in this study are not keen on the cricket-based porridges recommended to be good for complementary feeding [22]. This can be attributed to the knowledge gap on the importance of cricket-based diet for child-feeding. For most agencies concerned with promoting healthy population, maternal and child nutrition are known to be at the center of their nutritional intervention programs where mothers would normally receive pre-natal and post-natal nutritional care including nutrient supplements and dietary counselling [44]. It is apparent that such nutrition advice does not inculcate or emphasize insect-based diets for nutrition, thus calling for edible insects' inclusion into maternal nutrition education.

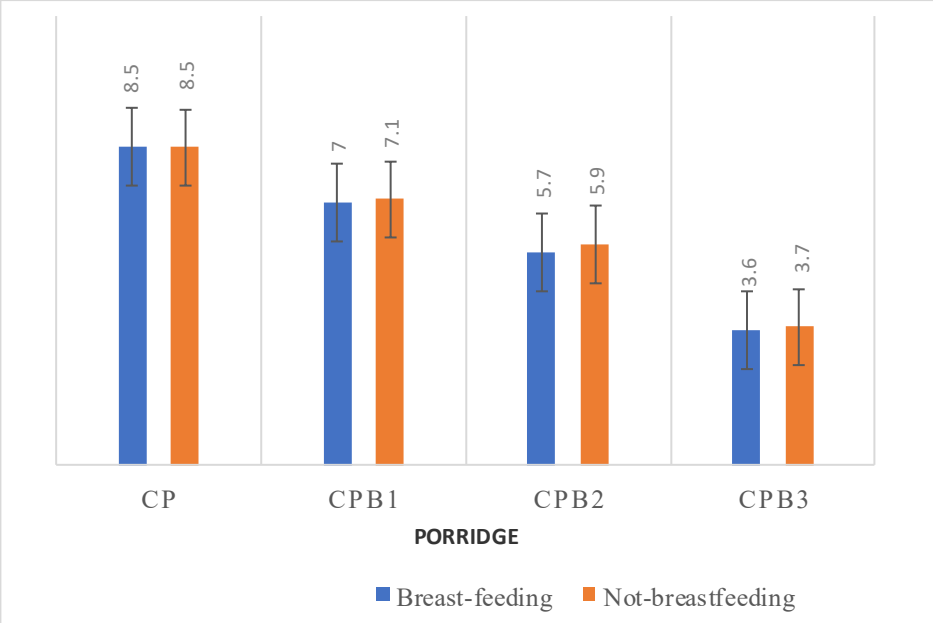


**Figure 4: Overall acceptability based on breastfeeding status**

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## CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

Age, education, occupation and income levels influenced acceptability of cricket-based porridges. Marital status and breast-feeding status had insignificant influence on acceptability of cricket-based porridges. Observation made from the study show that nutritional and health benefits of foods as a guide for dietary selection is still not emphasized by consumers. Instead, beliefs and perception about foods seem to overshadow any other benefit foods might confer. Devising ways to discourage insect-food neophobia including beliefs, negative perceptions and safety concerns is needed to improve edible insects' acceptability. At the same time, sensitization should be intensified and focused on the nutritional, environmental and economic benefits of edible insects.

### Authors' contribution

The first author conceptualized and conducted the study, interpreted findings, and drafted the manuscript. The second and the third authors contributed to conceptualization of the study, interpretation of the results, critically reviewed and approved the final version of the manuscript for publication.

### Conflict of interest

The authors declare no conflict of interest.

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**Table 1: Ratio of ingredients in the composite formula**

| Flour | Maize Flour (%) | Wheat Flour (%) | Soybean Flour (%) | Cricket Flour (%) |
|---|---|---|---|---|
| CP | 50 | 25 | 25 | 0 |
| CPB1 | 50 | 25 | 18.75 | 6.25 |
| CPB2 | 50 | 25 | 12.5 | 12.5 |
| CPB3 | 50 | 25 | 6.25 | 18.75 |

**Table 2: Proximate composition of the sample flours (g/100 g)**

| Flour | Moisture | Ash | Fibre | Protein | Fat | Carbohydrate |
|---|---|---|---|---|---|---|
| CP | 9.45±0.15$^{a}$ | 1.78±0.32$^{a}$ | 4.63±0.18$^{a}$ | 17.58±0.23$^{a}$ | 9.87±0.75$^{a}$ | 56.69±0.55$^{a}$ |
| CPB1 | 9.30 ±0.10$^{ab}$ | 1.67 ±0.16$^{a}$ | 5.41±0.56$^{b}$ | 19.18±0.28$^{b}$ | 11.04±0.70$^{b}$ | 52.77±0.02$^{b}$ |
| CPB2 | 9.63 ±0.13$^{a}$ | 2.13 ±3.90$^{a}$ | 7.45±0.28$^{c}$ | 21.04±0.19$^{c}$ | 14.02±0.35$^{c}$ | 45.73±0.55$^{c}$ |
| CPB3 | 9.25 ±0.01$^{b}$ | 1.72± 0.45$^{a}$ | 9.06± 0.12$^{d}$ | 22.87±0.45$^{d}$ | 15.61±0.3$^{d}$ | 41.49±0.51$^{d}$ |
| p-value | 0.0197 | 0.8536 | 0.0001 | 0.0003 | 0.0002 | 0.0001 |

Values are presented as Mean ± SD on dry matter basis (n=3), where n is the number of analytical replicates for each treatment
Values in each column followed by different superscripts differ significantly ($p \leq 0.05$) (19)

**Table 3: Mineral content of the flours in mg/100g**

| Flour | K | Ca | Na | Fe | P | Mg | Zn |
|---|---|---|---|---|---|---|---|
| CP | 177.53±0.09$^{a}$ | 87.58±0.47$^{a}$ | 82.22±0.73$^{a}$ | 6.05±0.14$^{a}$ | 128.97±1.09$^{a}$ | 31.63±0.38$^{a}$ | 5.84±0.79$^{a}$ |
| CPB1 | 188.28±0.62$^{b}$ | 83.19±0.45$^{b}$ | 92.35±0.45$^{b}$ | 5.43±0.08$^{a}$ | 125.44±1.24$^{b}$ | 34.10±0.76$^{b}$ | 6.34±0.05$^{a}$ |
| CPB2 | 194.45±0.71$^{c}$ | 78.35±0.23$^{c}$ | 110.55±0.12$^{c}$ | 4.15±0.15$^{b}$ | 121.50±1.07$^{c}$ | 41.70±1.87$^{c}$ | 8.21±0.72$^{b}$ |
| CPB3 | 196.97±0.90$^{d}$ | 75.90±0.52$^{d}$ | 119.05±0.34$^{d}$ | 3.12±0.1$^{c}$ | 118.42±1.13$^{d}$ | 46.07±0.12$^{d}$ | 9.44±0.12$^{c}$ |
| p-value | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |

Values are presented as Mean ± SD, n=3, where n is the number of analytical replicates for each treatment
Values in each column followed by different superscripts differ significantly ($p \leq 0.05$) (19)

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**Table 4: Results of overall sensory evaluation**

| Porridge flour | Colour | Texture | Aroma | Taste | Mouth- feel | Overall acceptability |
|---|---|---|---|---|---|---|
| CP | 8.08±1.47$^{a}$ | 7.60±1.67$^{a}$ | 8.25±1.28$^{a}$ | 8.35±0.74$^{a}$ | 7.65±1.70$^{a}$ | 8.5±0.72$^{a}$ |
| CPB1 | 6.98±1.14$^{b}$ | 6.88±1.52$^{a}$ | 6.98±1.42$^{b}$ | 6.85±1.48$^{b}$ | 6.90±1.48$^{a}$ | 7.08±0.94$^{b}$ |
| CPB2 | 5.83±1.72$^{c}$ | 5.4±1.95$^{b}$ | 4.85±1.64$^{c}$ | 5.05±1.90$^{c}$ | 5.08±1.97$^{b}$ | 5.75±1.53$^{c}$ |
| CPB3 | 4.25±2.25$^{d}$ | 3.35±2.10$^{c}$ | 3.43±1.99$^{d}$ | 3.65±2.13$^{d}$ | 3.40±1.93$^{c}$ | 3.60±1.95$^{d}$ |
| P-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Values are presented as Mean ± SD, n=40; where n is the number of observations recorded for each parameter

Values within each column followed by different superscripts differ significantly ($p \leq 0.05$)

**Table 5: Socio-demographic characteristics and breast-feeding status of respondents**

| characteristics | category | frequency | percentage (%) |
|---|---|---|---|
| Age | 15-19 | 10 | 25.0 |
| | 20-29 | 11 | 27.5 |
| | 30-39 | 9 | 22.5 |
| | 40-45 | 10 | 25.0 |
| Marital status | Single | 11 | 27.5 |
| | Married | 29 | 72.5 |
| Education | Primary | 9 | 22.5 |
| | Secondary | 13 | 32.5 |
| | Tertiary | 18 | 45 |
| Occupation | Student | 8 | 20 |
| | Farmer | 9 | 22.5 |
| | Business | 13 | 32.5 |
| | Formal employment | 10 | 25 |
| Monthly income | Less than US$ 50 | 8 | 20 |
| | US$ 50-100 | 17 | 42.5 |
| | US$ 101-150 | 8 | 20 |
| | US$ 151-200 | 3 | 7.5 |
| | Above US$ 200 | 4 | 10 |
| Breast-feeding status | Breastfeeding | 16 | 40 |
| | Not breastfeeding | 24 | 60 |

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**Table 6: Acceptability of porridges based on age of study respondents**

| Age in years | Porridge | Overall acceptability |
|---|---|---|
| 15-19 | CP | 8.67±0.00[a] |
| | CPB1 | 5.75±1.71[b] |
| | CPB2 | 4.25±2.22[c] |
| | CPB3 | 2.25±2.50[d] |
| 20-29 | CP | 8.23±0.72[a] |
| | CPB1 | 7.12±0.70[b] |
| | CPB2 | 5.73±1.06[c] |
| | CPB3 | 4.00±1.67[d] |
| 30-39 | CP | 7.23±0.74[a] |
| | CPB1 | 7.50±0.99[a] |
| | CPB2 | 6.82±1.79[a] |
| | CPB3 | 6.43±2.13[a] |
| 40-45 | CP | 7.22±0.82[a] |
| | CPB1 | 7.57±0.58[a] |
| | CPB2 | 7.20±0.96[a] |
| | CPB3 | 6.80±1.50[a] |

Values are presented as Mean ± SD (n=40)
Values within each column followed by different superscripts differ significantly (P≤ 0.05)

**Table 7: Overall acceptability of porridges based on level of education of study women**

| Education level attained | Porridge | Overall Acceptability |
|---|---|---|
| Primary | CP | 8.67±0.71[a] |
| | CPB1 | 6.54±0.71[b] |
| | CPB2 | 5.37±1.94[c] |
| | CPB3 | 3.78±2.44[d] |
| Secondary | CP | 8.53±0.62[a] |
| | CPB1 | 7.22±1.00[b] |
| | CPB2 | 6.59±1.74[b] |
| | CPB3 | 5.36±2.00[c] |
| Tertiary | CP | 7.57±0.89[a] |
| | CPB1 | 6.34±0.84[a] |
| | CPB2 | 6.75±0.54[a] |
| | CPB3 | 6.85±1.49[a] |

Values are presented as Mean ± SD (n=40)
Values within each column followed by different superscripts differ significantly (P≤ 0.05)

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