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# ACCEPTABILITY OF COMPLEMENTARY PORRIDGE ENRICHED WITH CRICKET FLOUR COMPARED TO CORN-SOY BLEND PLUS AMONG CHILD-CAREGIVER DYADS IN SIAYA COUNTY, KENYA

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## ABSTRACT

In the recent past there has been a global interest in insects as human food, yet their acceptability in some populations remains a challenge. This challenge, deprives the world of an alternative protein, as well as essential vitamins and minerals found in insects. This evaluation study was nested in a randomized control trial (RCT) to establish the comparative levels of acceptability of porridge made from flour enriched with edible cricket (+CR) and another from Corn-Soy Blend Plus (-CR), when fed to children from 6-14 months of age. The child's acceptability was monitored in the entire period of RCT implementation with qualitative evaluation done at the end of RCT implementation. Four focus group discussions (FGDs) were conducted with the caregivers while child's acceptability was assessed by the frequency of consumption and how well the child signaled for more porridge during feeding from routine data collected monthly over the eight months trial period. The two porridges at the first revisit, had an acceptability level of 79.7% and 80.3% which rose to 98.3% and 99.2% for +CR and -CR, respectively over the 8-month period. During the seven monthly revisits, the enrolled children aggressively signaled for more porridge in an average of 5.6 visits for the two porridges. Qualitative evaluation results reveal that at the onset of the study and introduction of the new food, mothers were anxious and this cleared as the child accepted the new food. This observed high level of acceptance can largely be attributed to the porridge's organoleptic (such as aroma, texture and taste) properties, energy contribution observed in child activity and how the child consumed it when offered. High level of acceptance of the two porridges and particularly, the one enriched with cricket powder, emphasizes the significance of timing, sensory aspects and society stance. This study, therefore, recommends early introduction with a repeated consumption of a tasty, safely processed /cooked and served cricket-based food for a higher acceptability.

**Key words:** Acceptability, insects, crickets, complementary feeding, child, porridge, sensory

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## INTRODUCTION

The growing population, shrinking agricultural land, and soaring food prices has led to the search for alternative sources of food for both humans and animals with active industrial, policy and scientific community's contribution [1]. A number of insects due to their abundance and rapid growth are currently being considered as alternative food for mankind and domestic animals [2]. In spite of the global efforts to produce insects for food, the question of acceptability and sustainable utility of the insects as food, remains complex and is yet to be fully explored [3].

Currently, the rejection of insect diets is associated with varied factors including: allergic reaction [4], consideration of insects as pests which are viewed as food contaminants[5], perception of insects as food for vulnerable or people of low social status [5], as well as psychological barriers leading to neophobia and disgust [6, 7]. Rejection largely occurs when insects are served whole whereas products enriched with insect powder such as biscuits and bread, receive a comparatively higher level of acceptability than serving of whole insects [3]. Implicit acceptability challenge is partly driven by imagination and the sight of the insect morphological features [8, 9]. Acceptability is however, improved and sustained with information on the functional value of insect, when the safety concerns are addressed, and the consumption of insects receives religious backing [10, 11]. Additionally, level of sustainable acceptability vary by ones' age, educational level, desire to go green, insect availability and individuals' historical practices of insect consumption [5, 12].

A study assessing acceptability of cricket-based porridge among adults in Siaya County, Kenya found that: consumption choices were informed by personal belief and perception of the food but not based on the nutritional nor health benefit, while acceptability levels were negatively associated with marital status and breastfeeding status and positively associated with age and education level [12]. Willingness to taste is the gate-way to full consumption of any food [3]. Once able to taste, the sensory quality, level of food information and current immediate societal beliefs play the next influential role in sustained consumption. As a result, any insect enriched food exhibiting sensory properties similar to known common food, with known functional properties and nutritional value, receives high acceptance in communities engaging in positive conversations regarding insect as food [12, 13].

Inclusion of insects in children's diet is desired for improved protein, vitamins and essential mineral intake. And especially during complementary feeding (CF), when breast milk alone or infant formula alone is no longer sufficient to meet the nutritional requirements of infants [14]. Complementary feeding involves introduction of other foods and liquids along with human breastmilk or a breastmilk substitute, and is

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influenced by geographical region, family traditions, culture, beliefs, availability, cost and caregivers' knowledge on food items [15]. Across Kenya complementary feeds are heavily starch-based, with calcium, animal source protein, zinc and iron being less affordable and regionally varied [16]. A starchy CF base can and has been enriched using food-based approaches by adding other grains, legumes, vegetables, fish, insects and other animal products [17].

In spite of insects being consumed by over 2.5 billion people in the world (ref), there still exists a significant level of insect rejection amongst some human populations [18]. This level of rejection, deprives the world of an alternative protein, essential vitamins and minerals found in insects. It is, therefore, essential to continually innovate, prepare and introduce the insect -based foods in new forms to enhance their acceptability. In this study, two complementary porridges, one made from cricket enriched flour (+CR) and the other Corn-Soy Blend Plus (-CR) were assessed with a view to comparatively determine their level of consumer acceptability.

## MATERIALS AND METHODS

This study is an evaluation of one of the treatments (complementary porridges) used in a randomized 2 × 2 factorial trial (https://clinicaltrials.gov, ID number: NCT06002620). The main study focused on the effect of complementary porridges with or without nutrition education, hence had 4 study arms: cricket treatment with education treatment (+CR and +ED; n=70), cricket treatment with no education treatment (+CR and -ED; n=71), no cricket treatment with education treatment (-CR and +ED; n=70), and no cricket treatment with no education treatment (-CR and -ED; n=73). All mothers in the main study were trained on how to prepare the study porridge with a total of 140 randomized to nutrition education arm. This evaluation study was implemented using a mixed method nested in the main trial to determine level of acceptability of the two study porridges, cricket enriched flour (+CR) and Corn-Soy Blend Plus (-CR) fed to children from 6 months of age for a period of 8 months. The +CR porridge had 24% cricket powder added to the flour composition while the -CR porridge was a standard Corn-Soy Blend Plus also referred to as super cereal [19].

Both quantitative and qualitative data were collected to determine level and reasons for the acceptability of the two study porridges. The quantitative evaluation was based on the child's continued consumption of the study porridge and data collected monthly whereas the qualitative focused on the mother's observation during child feeding and overall acceptability as caregiver. From each of the four study arms, nine randomly selected mothers were invited to participate in the focus group discussions with minimum number of participants per FGD set at five caregivers. A

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total of 29 mothers participated in the four FGDs, one FGD per study arm. The Focus Group Discussions (FGDs) were conducted, two weeks after the end of the main trial period, at the quiet project office within Rwambwa sub-County hospital, Siaya County, Kenya. The acceptance of the study porridges was monitored over the trial period by the frequency of monthly portion picked and monthly question on consumption, as responded to by the mother. The mother's response was based on child observation reported at every visit. The mother observed and reported how well the child signaled for more porridge during the last feeding prior to study visit. Negative food cues such as spitting out the porridge, vomiting while fed on the porridge or turning the head away from the porridge during feeding were considered rejection of the study porridge. The porridge was considered acceptable, if the child continued to consume it to the last date of main trial without ever completely rejecting it midway.

During feeding, the child's facial responses are sometimes in concord with consumption, whereas in other cases, it is a reactivity following changes in intake amounts. Child feeding was, therefore, controlled for individual differences in rates of feeding and orofacial expression observed to determine child's acceptance or rejection cues. Feeding control was done while focusing on the overall facial expressions for each of the initial 3 spoons offered during the last feeding prior to clinic visit for every new food supply. In addition the mothers reported on any other specific commonly repeated facial responses observed over the 8 months period [20]. The validity of information about food sharing practices was difficult to completely ascertain, with some degree of socially desirable response bias expected in this study. To limit this, the research assistant administering evaluation FGDs was not involved in administering main study and the evaluation FGDs were conducted once the main study had officially closed. Nevertheless, the perceptions expressed by mothers are, to some extent, a reflection of the information provided by the study team during implementation.

During the monthly visits, the child health history was taken with questions about child diarrhea and vomiting consistently administered. In rating the porridge, the caregivers were asked to give their overall rating for the porridge quality and their willingness to recommend the porridge to other mothers in a scale of 1-10 with 10 being the best porridge ever given to their child at every visit. Comparatively the proportional difference in level of acceptance for the two porridges was assessed and episodes of diarrhea compared for the two porridges. Quantitative data was analyzed using summary statistics indicating rating scores in terms of proportions, means and standard deviation with graphical presentation of the acceptability trends over the trial period. The FGD recorded audio were transcribed verbatim then

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analyzed using narrative analysis method. Narrative method was used to understand caregivers' personal stories with a focus to depict the overall common story the mothers were sharing. Mothers in the FGD expressed themselves in Swahili or Luo which is reported in the spoken verbatim and translated in context [21].

The Ethical approval for the main trial, including the trial monitoring and evaluation, was obtained from Institutional Scientific Ethics Review Committee of the university of East Africa Baraton (UEAB/ISERC/23/12/2022). The research permit was obtained from National Commission for Science, Technology and Innovation (NACOSTI) (Ref No. 475925). And an informed consent to participate and allow voice capture was obtained from all participating caregiverss.

## RESULTS AND DISCUSSION

### Demographic characteristics of the focus group discussion participants

The demographic characteristics of the 29 randomly selected caregivers (sub-population) who took part in the FGDs is presented in Table 1. Generally, the socio-demographic distribution of selected caregivers was randomly distributed across the treatment groups. The participating mothers were largely holders of primary education qualification (62.1%), 93.0% were food insecure, 72.4% lived in semi-permanent houses and with 5-9 household members (69.0%) in the four study arms. The distribution of the participants per treatment arm was comparatively equal.

### Acceptability trend over time

All the children in the study consumed the porridge throughout their individual stay in the study without a complete outright porridge rejection. By gauging all the trial children on how aggressively they demanded the next bite, resulted in similar outcome with a consistent rise in acceptability observed over time. The two study porridges at first revisit, had an acceptability level of 79.7% and 80.3% which rose to 98.3% and 99.2% for +CR and -CR, respectively over the 8-month period. The consistent rise, consequently resulted in the dropping trend in rejection behavior (Figure 1a and Figure 1b)

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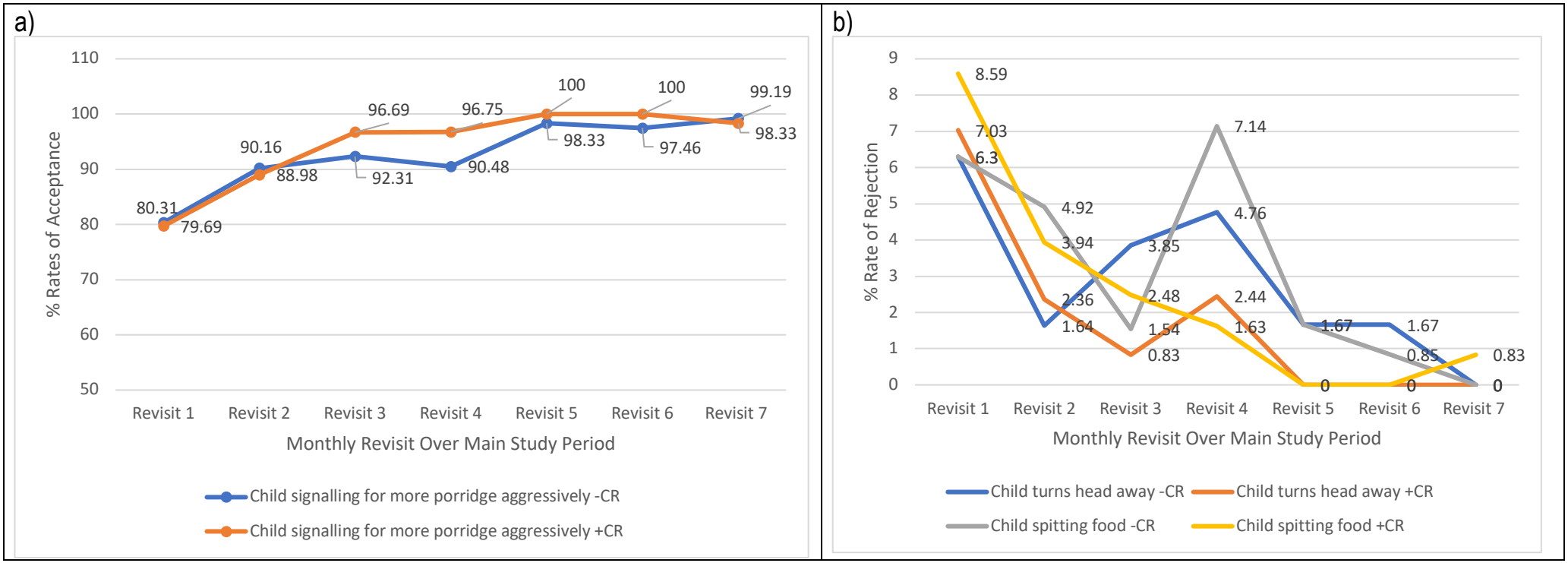


**Figure 1: Trend of porridge a) acceptability measured by the child aggressively signaling for more porridge and b) rejection measured by negative food cues mainly, child turning head away and spitting out the food over the period the main study was implemented**

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The low uptake of the porridge at onset can be explained by the mothers' initial averseness to insect consumption, being a new food to the child. They were however encouraged by how the child consumed the study porridge with some mothers saying:

R7: … unga nasema ilikuwa mzuri sana waah kulingana na venye mtoto alikuwa anaikunywa uji naweza sema ilikuwa mzuri sana juu pia wakati nilikuwa namjaribu na ingine ya kawaida alikataa, which means hii yenu ilikuwa sawa aii ikafanya mtoto akakuwa healthy akakuwa strong. Naa, nilikuwa nai doubt mwanzo mwanzo but niliona kama inampeleka vizuri. Eee sijaona shida yoyote ***(Following how the child consumed it, the porridge was very good, because when I introduced alternative porridge the child rejected, this study porridge made the child strong and healthy. At the onset I doubted it but it has done the child great without any challenge)*** [FGD2; +CR Porridge; R7]

R4: ….. venye nilianza ya kwanza uji ilimsumbua lakini baadaye akashika mita. Sasa ilikuwa inampeleka vizuri tena alikuwa healthy sana ***(at the start the child had a challenge but with time got used to the study porridge and is very healthy)*** [FGD3; -CR Porridge; R4]

Over time the acceptance trend increased with some level of fluctuations (Figure 1a) which could be explained by the observations that: when introducing any new food or switching over to alternative food sourced elsewhere including shop and homemade, children experienced stomach discomfort. This discomfort resulted in diarrhea which cleared off with repeated consumption of the new food or resumption of what the child was used to. This is confirmed by the following quotes:

R4: …. to kamiye macha [alternative porridge] to aneno kodiewo koro immediately mane ochakomadho mano [study porridge] to aneno kaoonge gishida moro amora omadhe ma ka nyuka makoro ohero ***(…..when I gave my child the alternative porridge the child would have diarrhea but when on study porridge the child has no problem and takes it happily)*** [FGD1; -CR Porridge; R4]

R5: ….mtoto alikuwa anakunywa vizuri na anaendelea vizuri na lakini na ikiisha tu hivi uanze kumpa hii ingine saa zingine nilikuwa naona anaanza kuharahara kidogo aki kunywa hii ingine lakini tena akianza kuendelea na hii ingine sikuwa nikiona aki hara hiyo ndiyo changamoto. Niliona wakati unga ilikuwa imeisha nikaanza hii ingine lakini vile alikuwa anakunywa hiyo sikuona hata akihara hata siku moja. …. Wakati huo unga ulikuwa umeisha nilikuwa naanza kumpatia hii ingine hapo ndiyo nilikuwa na ugumu lakini tena nikija tena nichukuwe hii na kuendelea kupatia hapo tena mambo ilikuwa ikiendelea … kwa sababu alikuwa anaendelea kunywa tu kama kawaida. ***(On the study porridge the child would do well and a change to alternative porridge meant force feeding and would be followed by diarrheal episodes which cleared with continuous use of the alternative but***

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***when returning to study porridge was happy feeding and no experience of diarrhea)*** [FGD2; +CR Porridge; R5]

These findings confirm that people gain the confidence to consume new food based on their own perceived benefit and similarity to common food. It is the appearance and aroma of the served food that inspires the desire to have a taste. Just like most mothers in other studies, the mothers in this study experienced anxiety that could be associated with introduction of complementary food and early child feeding practices [22, 23].

The mother's acceptance of the study porridges and the child's liking of the porridge was key to its acceptance. This positive acceptance of the porridge also provided a relief to maternal mental health by making the mothers have a positive interaction with the child during feeding [22]. The surrounding too is critical to the acceptance of new food with the perception and comments by the people in the surrounding playing a role in the acceptance of the new food. In this study, for both the baby and the mother, home environment was a familiar surrounding hence perfect for feeding the child. And the mothers were largely motivated by the child's positive food cue during initial feeding on the porridge, this inspired the mother to continue feeding on the porridge. Further to that, the experience following the first taste by the recipient was critical in the sustained uptake. The experience of the child indicates that experiencing a taste that meets or exceeds expectation is a fundamental driver of acceptability [3, 24].

A further analysis to assess the acceptability level for all the children who completed the main study was conducted. And in a scale of one to seven times, the children signaled for more porridge aggressively at an overall mean score of 5.6±1.6 times (+CR (5.7±1.6) against -CR (5.6±1.6)) (Table 2). Of those caregivers (n=239) who observed aggressive signaling for more porridge 50.6% were from the nutrition education arm. When caregivers were asked to give their overall rating for the quality of the study porridge in a scale of 1-10 (10 being the best porridge ever given to their child), both porridges were rated equally (at mean±SD of 8.5 ±1.5 for +CR and mean±SD of 8.6 ±1.4 for -CR). And the care-givers in the study were willing to recommend the porridge to other mothers at a mean±SD of 8.5 ±1.4 for +CR and mean±SD of 8.5 ±1.5 for -CR (Table 2). According to the caregivers, the porridge was appreciated for, its organoleptic (such as aroma, texture and taste) properties and energy contribution. The aroma was strong enough, setting the study porridge apart from any other alternative foods, making it easy for the child to identify. Caregivers' statements and expression explaining the challenges they experienced whenever they missed the porridge also confirms acceptability of the study porridge:

R1: ……alikuwa anaichukuwa vizuri akiweka kwa mapua ana jua ni hiyo na anakunywa ***(....my child brought closer to the nose and would identify it from the aroma then feed)*** [FGD1; -CR Porridge; R1]

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R3: So ilinilazimu nimlazimishe cause alikuwa amezoea ile na hiyo …. na all over a sudden unabadilisha so ili azoe hii ilikuwa …challenge but so alikuwa ame base kwa maziwa lakini hii amezoea tu vizuri ***(I had to force feed as the child liked the study porridge and suddenly had to return to local alternative porridge when study porridge was over. I had to depend on milk as better alternative the child accepts)*** [FGD4; +CR Porridge; R3]

R3: … sani ok ane ka odhoth ahinya yani sama ong'iyo gi nyukani chalne gi chak mar thuno nikech nyukani yom mogoni yom. Koro sama oginene samomadho nyukani ok odhodh ahinya kaka yande odhoth ….. sama omadhonyuka cha koro thunono ok o depend e ahinya kaka sani otek ojing onyalo ringo moingo kaka ne en ko madho nyuka moko ka ne hinye samatin iye kuot mato komadho to odhiaadhia mayom ***(…upon introduction to the study flour, the child reduced rate of breast feeding because this porridge is finely ground …. the child is very energetic and more active than before when I used the other porridge which led to constipation)*** [FGD1; -CR Porridge; R3]

R2: Agoyo erokamano gima mogoni otimona. Omiyo nyathina sani strong sani en ngat moro makata ka arango gi nyamingi maneonge e migawo mar mogoni en weak nyaka sani pod en weak. Lakini mogoni osekonyo na mihiani omiyo mihichani sani en strong ***(I am grateful for what this porridge has done to me, it has made my child stronger than the older sibling who was not in this study and remains weak to date. This porridge has helped my child)*** [FGD1; -CR Porridge; R2]

R7: … kulingana na venye mtoto alikuwa anakunywa uji naweza sema ilikuwa mzuri sana juu pia wakati nilikuwa namjaribu na ingine ya kawaida alikataa, which means hii yenu ilikuwa sawa ***(From observation this porridge is very good the child took it very well and has since rejected the local alternative porridge)*** [FGD2; +CR Porridge; R7]

Rejection level of +CR dropped from 8.6% at onset of study to approximately 0% by end of the study with the exception of one child (0.8%) who exhibited spitting behaviors while eating the +CR porridge at the last visit (Figure 1b). All dislike attributes tested in the study were rated on average with a score less than 1 time (See Table 2). According to the caregivers, not liking the alternative foods was above 60%, with more than 30% strongly disliking the alternative food offered at home. Approximately 6% of the children completely rejected the alternative while over 50% consumed it reluctantly. The mothers' accounts, indicate the study porridge was preferred compared to the alternatives bought or processed at home as indicated in the following quotes:

R1: Wangu naye mwanzoni nilikuwa nampeanga ile famila sasa vile nilijaribu hii nikaona amekataa famila hadi saa hii sasa vile siku zake zilifika ali stopishiwa sasa siku hizi hakunywangi uji ukimpea na anasukuma kikombe juu alikuwa amezoea

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ile … na unga alikuwa analamba hata ukichukuwa kidogo uweke kwa sahani analamba ***(my child was taking porridge from the shop but when I introduced the study porridge the child rejected the porridge from shop to date even now that the study phase is over the child pushes off mug of the alternative porridge…the child would lick the study flour directly in its powder form)*** [FGD1; -CR Porridge; R1]

R1: Hii uji kulingana na vile ilikuwa mzuri …… na hiyo uji tumeona ilikuwa mzuri sana hata kushinda za duka ***(this porridge was very good and much better than the one I get from the shops)*** [FGD2; +CR Porridge; R1]

R2: …. uji umetupatia imeisha kama haijafika date yenye uliandikiwa sasa ilikuwa inaniletea changamoto cause unapata hataki za duka , ashazoea hii na hii pia imeisha saa ilikuwa inabaki tu namweka maziwa kwa sasa asikose kitu kama….pia si kosi eeh sasa ikifika ile ya kuchukuwa ile naendelea tu nayo lakini ya duka nayo ilishindikana mpaka wa leo hataki so nikaachana tu nayo ***(The study porridge would run out before next appointment date and return to the old porridge was a challenge as the child disliked the flour bought at the shops because the child is used to the study porridge)*** [FGD3; -CR Porridge; R2]

From the level of porridge acceptance and caregiver experiences, it is believed that the potential health benefits, porridge taste and the cooking training the mothers received were inspirational. They inspired the mothers' initial will to feed the child leading to the sustained uptake of the study porridge. The observation of caregivers at the end of the trial, indicates the porridge filled part of the food and diet diversity gap for the child while reducing constipation. Such perceived benefits could have also inspired the sustained level of acceptability.

The high acceptance rate observed could be attributed to the age at which this new food was introduced. Given the varied mothers' diet, breastfed children upon entering complementary stage in life are equipped with a set of predispositions facilitating acceptance of foods with varied flavor texture and tastes; sweet, salty, sour or bitter [25]. This predisposition shapes a child's food preferences based on repeated experiences in a positive reassuring context [26]. For these children the entry age (6 months) was early enough for enhanced acceptance of varied food with their mothers being the critical enablers for repeated access to +CR porridge. Repeated exposure to food of between eight to ten tastes, increases a child's familiarity to the food while increasing their willingness to consume it [13]. The promotion of the introduction of a variety of other foods emphasized through nutrition education intervention could also have modulated the acceptance of the study porridge. This probably explains the initially comparatively low acceptability baseline rate for +CR (79%) which consistently improves with repeated consumption as the child gets accustomed to the taste and texture of +CR porridge leading

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to the 99% acceptance rate at the end of the study giving almost 100% acceptance of cricket enriched porridge amongst children.

The high acceptance rate observed in this study, is consistent with the findings of other studies on acceptability of edible insects such as Bouhlal *et al.* [27], Anyasi *et al.* [28] and Konyole *et al.* [29]. Anyasi *et al.* [28] in their study concluded that innovative edible insect diets are gaining acceptance, Konyole *et al.* [29], confirmed acceptability of products enriched with white termites whereas Bouhlal *et al.* [27], argued that exposure to a variety of foods during complementary feeding modulates acceptance of new food in the first year of life better than if introduced later. Early exposure is also confirmed by Finistrella *et al.* [30] who elaborates on the influence a supportive caregiver at this early stage of life. The choice of porridge, refined porridge recipes and texture aligned with local food for the child of this age was important. This choice of a common food type might also have naturalized the food taste in the local context, as organoleptic properties of new food are a strong predictor of new food acceptability, emphasizing the importance of skilled food preparation resulting in a tasty food that meets or exceed local taste expectation. The inclusion of a feedback loop during the feeding period was a critical step towards enhancing acceptability, with emphasis on capturing caregiver experience and using it to improve feeding experience [31].

Approximately 82% of the children never experienced vomiting nor diarrhea during the follow-up period. Of the remaining 18%, a total of 20 (8.2%) children suffered both diarrhea and vomiting while the rest suffered either diarrhea [10 (4.1%)] or vomiting [14 (5.7%)]. Some of the mothers associated the study porridge and the available alternative to the health of their children. They appreciated how well the child's health improved on study porridge and observed either diarrhea or constipation while on alternative porridge as confirmed by the following quotes:

R5: Kwa mtoto ilisaidia, juu wakati nilianza feeding nilianza na hiyo porridge. Nikaona anaendelea nayo poa, alikuwa kilo kidogo but with time ali grow haraka haraka compaired to others, my previous kids. So akakuwa active then ugonjwa hakuwa nayo. Vile alikuwa nayo mwanzo aki.. from 1 month to 6 months. Tulikuwa on and off to the hospital but immediately tulianza kuja hapa akanzakutumia hiyo uji ikamsaidia kabisa. ***(To the child the porridge was helpful, I introduced the child to this porridge as first solids and observed the child grow fast beginning with low weight and rapidly gaining weight compared to my other previous kids, getting active and with no ailments as was in the earlier months before month 6, when I was on and off the hospital. But when the child was started on this porridge the child benefitted)*** [FGD1; -CR Porridge; R5]

R2: … hiyo unga ilikuwa mzuri kwa sababu huyu mtoto wangu anadhoofika kila saa alikuwa na magonjwa hakukuwa na afya nzuri, lakini niliona tofauti. ***(My child was***

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***sickly but when I put the child on study porridge, I saw a difference so the flour is good)*** [FGD2; +CR Porridge; R2]

R4: …. kwa upande wangu hii uji niliona na mpea mtoto akienda haja kubwa anaenda vizuri ikiisha nimpea yangu ya kusiaga tu akienda haja kubwa ni ngumu kidogo. ***(when my child was on study porridge defecation was ok but when I gave what I prepared/ground at home the child gets constipated)*** [FGD2; +CR Porridge; R4]

R3: … ber ma aneno e mogoni an mihichani ne achako ruwone nyuka moko ma wa ma wanyiewo eduka gi ne ayudo ni ok dhikode maber, iye moko iye korore ko dhi e cho ok odhi maber. ***(What pleased me while on this study flour, my child started taking porridge made from flour bought in local shops which did not go well as the child was always constipated and having problems defecating)*** [FGD1; -CR Porridge; R3]

Additionally, the non-significant difference (p= 0.60) in proportional rating, non-significant (p>0.05) disease episodes and diarrheal episodes' distribution (Table 3) confirmed high acceptability level of either porridge. From the findings, some of the caregivers may have solely relied on the study porridge leading to the children rejecting the alternative foods offered. Whereas the others who offered a variety as they were trained could explain the action of the child eating all the foods served. This points to the significance of feeding a child in variety of food and not a single food type in the early life of a child [30]. In dealing with the rejection of alternatives, mothers would wait until the children were hungry to feed them, taking advantage of hunger to drive uptake of the alternative food. Overall, the findings align with the findings of other authors who argue that knowledge on insect nutritional value, societal stance, eating environment and individual stance results in either a rejection or acceptability [13, 24].

## CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

In conclusion, the porridges were highly accepted by both the caregiver and child irrespective of whether it contained crickets or not. This implies that early introduction, gradual exposure with a repeated consumption of a tasty, well prepared and served cricket-based food enhances the culinary experience leading to high acceptability. This emphasizes the importance of introduction time, sensory aspects, and the contribution of societal stance in food acceptability. This reveals the need for nutrition education and training that covers concepts of early introduction of a variety of new foods, effect of sensory properties and community sensitization on edible cricket as available nutritious protein source for sustained acceptance and wider consumption.

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## Limitation

Observations of child facial expression were solely done by the mother which is susceptible to socially desirable response bias. We, therefore, recommend direct observed or video recorded facial expression where both mother and independent observer determines level of acceptability.

## Conflict of Interest

The authors declare that they have no conflicts of interest.

## Contributor Statement

NO, AS and SK performed the research fieldwork. NO, AS, SK and NR designed the research study. JK, NO, Kiiru, SK and JN developed and produced the study food. NO and SK analyzed and reviewed the data. NO and SK wrote the first draft of the manuscript. All authors reviewed and approved the manuscript.

## Data Availability Statement

The data supporting the findings of this study are available on request from the corresponding author. This data is not publicly available due to privacy or ethical restrictions.

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**Table 1: Socio-demographic characteristics of the mothers who participated in the Focus Group Discussions by treatment group**

| Socio Demographic Characteristics | | FGD 1 (n=7) -CR & +ED | FGD 2 (n=7) -CR & -ED | FGD3 (n=9) +CR & -ED | FGD 4 (n=6) +CR & +ED | Total | Chi | P-value |
|---|---|---|---|---|---|---|---|---|
| | | n (%) | n (%) | n (%) | n (%) | n (%) | | |
| Level of Household Food Insecurity Access | Food secure | 0 (0.0) | 0 (0.0) | 1 (11.1) | 0 (0.0) | 1 (3.7) | | |
| | Mildly food insecure access | 1 (14.3) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (3.7) | 6.46 | 0.69 |
| | Moderately food insecure access | 2 (28.6) | 4 (66.7) | 4 (44.4) | 3 (60.0) | 13 (48.1) | | |
| | Severely food insecure access | 4 (57.1) | 2 (33.3) | 4 (44.4) | 2 (40.0) | 12 (44.4) | | |
| Household Size | <5 Members | 4 (57.1) | 2 (28.6) | 1 (11.1) | 1 (16.7) | 8 (27.6) | | |
| | 5-9 Members | 3 (42.9) | 4 (57.1) | 8 (88.9) | 5 (83.3) | 20 (69.0) | 8.04 | 0.24 |
| | > 9 Members | 0 (0.0) | 1 (14.3) | 0 (0.0) | 0 (0.0) | 1 (3.4) | | |
| Type of housing (Main house) the family live in | Permanent | 1 (14).3 | 1 (14.3) | 1 (11.1) | 1 (16.7) | 4 (13.8) | | |
| | Semi-permanent | 6 (85.7) | 5 (71.4) | 6 (66.7) | 4 (66.7) | 21 (72.4) | 1.79 | 0.94 |
| | All temporary | 0 (0.0) | 1 (14.3) | 2 (16.7) | 1 (16.7) | 4 (13.8) | | |
| Main caregiver Education level | Primary and below | 4 (57.1) | 5 (71.4) | 5 (55.6) | 4 (66.7) | 18 (62.1) | 0.55 | 0.91 |
| | Secondary | 3 (42.9) | 2 (28.6) | 4 (44.4) | 2 (33.3) | 11 (37.9) | | |
| Household religious grouping | Indigenous churches | 1 (14.3) | 2 (28.6) | 4 (44.4) | 2 (33.3) | 9 (31.0) | | |
| | Catholic | 0 (0.0) | 1 (14.3) | 2 (22.2) | 1 (16.7) | 4 (13.8) | 4.64 | 0.591 |
| | Protestant | 6 (85.7) | 4 (57.1) | 3 (33.3) | 3 (50.0) | 16 (55.2) | | |
| Main Household's source of income | None/Remittance | 2 (28.6) | 3 (42.9) | 1 (11.1) | 0 (0.0) | 6 (20.7) | | |
| | Farming | 2 (28.6) | 2 (28.6) | 6 (66.7) | 1 (16.7) | 11 (37.9) | 13.2 | 0.15 |
| | Self Employed/Owns business | 3 (42.9) | 2 (28.6) | 1 (11.1) | 3 (50.0) | 9 (31.0) | | |
| | Salaried | 0 (0.0) | 0 (0.0) | 1 (11.1) | 2 (33.3) | 3 (10.3) | | |

+CR: cricket enriched porridge; -CR: Control porridge; +ED Nutrition Education offered; -ED No nutrition Education offered

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**Table 2: Child Observation and Care-givers' Comments on the Level of Acceptability of the Study Porridge**

| Observed child signals | +CR(n=122) (mean±SD) | -CR(122) (mean±SD) | Overall (244) (mean±SD) |
|---|---|---|---|
| Child signaling for more aggressively | 5.7±1.9 | 5.6±1.9 | 5.6±1.9 |
| Child accepts porridge passively | 0.2±0.5 | 0.2±0.6 | 0.2±0.5 |
| Child turns head away | 0.1±0.4 | 0.2±0.5 | 0.1±0.4 |
| Child spitting out food | 0.2±0.5 | 0.2±0.5 | 0.2±0.5 |
| Child crying, refusing to eat | 0.01±0.1 | 0.03±0.2 | 0.02±0.1 |
| Child crying, but eats | 0.1±0.3 | 0.1±0.4 | 0.1±0.3 |
| Child vomits | 0.01±0.1 | 0.01±0.1 | 0.01±0.1 |
| Care-givers' study porridge rating in a scale of 1 to 10 | 8.5±1.5 | 8.6±1.4 | 8.6±1.6 |
| Care-givers' willingness to recommend the study porridge if sold | 8.5±1.4 | 8.5±1.5 | 8.5±1.5 |

+CR cricket enriched porridge; -CR control porridge; mean±SD mean and the associated standard deviations

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## Table 3: Comparing the Association of Level of Acceptability and Child Disease Episodes Across the Study Porridges

| Characteristics | | +CR | -CR | Overall | | |
|---|---|---|---|---|---|---|
| | | n (%) | n (%) | n (%) | Chi | P-Value |
| Proportion of care-givers rating the porridge above 8/10 (243) | Yes | 97 (80.2) | 101 (82.8) | 198 (81.5) | | |
| | No | 24 (19.8) | 21 (17.2) | 45 (18.5) | 0.28 | 0.60 |
| | Total | 122 (100) | 121 (100) | 243 (100) | | |
| Observed child response to alternative food when study porridge flour is over (238) | Accepted highly | 42 (35.6) | 42 (35.0) | 84 (35.3) | | |
| | Reluctantly Accepted | 70 (59.3) | 69 (57.5) | 139 (58.4) | 0.59 | 0.74 |
| | Rejected | 6 (5.1) | 9 (7.5) | 15 (6.3) | | |
| | Total | 118 (100) | 120 (100) | 238 (100) | | |
| Care-givers' rating level for child's like or dislike of the alternative food offered (240) | Like extremely | 2 (1.7) | 3 (2.5) | 5 (2.1) | | |
| | Like slightly | 29 (24.6) | 27 (22.1) | 56 (23.3) | | |
| | Neither like nor dislike | 12 (10.2) | 5 (4.1) | 17 (7.1) | 3.99 | 0.41 |
| | Dislike slightly | 36 (30.5) | 41 (33.6) | 77 (32.1) | | |
| | Dislike extremely | 39 (33.1) | 46 (37.7) | 85 (35.4) | | |
| | Total | 118 (100) | 122 (100) | 240 (100) | | |
| Number of illness episodes the child experienced over the follow up period | 0 Episodes | 8 (6.6) | 6 (4.9) | 14 (5.7) | | |
| | 1-2 Episodes | 35 (28.7) | 35 (28.7) | 70 (28.7) | 0.37 | 0.95 |
| | 3-4 Episodes | 57 (46.7) | 57 (46.7) | 114 (46.7) | | |
| | 5+ Episodes | 22 (18.0) | 24 (19.7) | 46 (18.9) | | |
| | Total | 122 (100) | 122 (100) | 244 (100) | | |
| Episodes of diarrhea and/or vomiting over the follow-up period | None | 97 (79.5) | 103 (84.4) | 200 (82.0) | | |
| | Vomiting | 6 (4.9) | 4 (3.3) | 10 (4.1) | 1.07 | 0.79 |
| | Diarrhea | 8 (6.6) | 6 (4.9) | 14 (5.7) | | |
| | Diarrhea and Vomiting | 11 (9.0) | 9 (7.4) | 20 (8.2) | | |
| | Total | 122 (100) | 122 (100) | 244 (100) | | |

+CR cricket enriched porridge; -CR control porridge; proportion above 8/10 imply above 80% approval; p-values are chi square statistics

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