Effect of information on mothers' sensory and emotional profiling of insect-based porridges in Kenya

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Abstract:

Due to their nutritional value, insects are increasingly proposed as alternative food sources to address nutritional deficiencies. To better understand their potential for young children, this study aims to compare four insect-based instant porridges (termites and grasshoppers) and a standard 'control' instant porridge to examine how information about the health benefits and composition of the insect-based porridges impacts sensory perceptions and evoked emotions. A between-subjects design was set up using 337 mothers with children aged 6–23 months in western Kenya, randomly assigned to a control and informed condition. This study found that information had a negative significant effect on the liking of flavour and mouthfeel of insect-based instant porridges, but no significant effect on overall liking and the liking of the aroma. However, information had a positive significant effect on participants appreciation of sensory attributes such as adhesiveness, nutty mouthfeel and thickness of insect-based instant porridges. Regarding the effect of information on sensory evaluation, differences were reported depending on the type of porridge. Those informed mainly criticised the fishy aroma and fishy flavour in the porridges. In addition, the provision of information had a limited, albeit negative, influence on the emotions evoked by some types of instant porridge. The participants associated positive emotions with the porridges after tasting but the intensity of several positive emotions was lower in the informed group.

Keywords: insect-based foods; sensory evaluation; information; acceptance; WEIRD; porridge

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1. Introduction

Due to global population growth and associated food and nutrition security challenges, there is a need for alternative foods that are nutritious and sustainable (Premalatha et al., 2011, Raheem et al., 2019). Edible insects, as well as foods made from insect ingredients, are proposed as sustainable alternatives to traditional animal food sources. They are traditionally harvested from the wild and processed and marketed in various communities, but can also be reared (Tanga et al., 2021). Products derived from edible insects are consumed as delicacies, as complementary dishes or as a component of other existing food sources (Maiyo et al., 2022). More than 2 billion people from 113 countries, mainly in Asia, Africa and Latin America, consume about 1611 different insect species, of which 81 are medicinal insects (Barennes et al., 2015, van Itterbeeck & Pelozuelo, 2022). In Kenya, about 17 species of insects are used as food and feed, including desert locusts, grasshoppers, crickets, termites, honeybees, black ants, caterpillars, beetle grubs, etc. (Münke-Svendsen et al., 2016, Mulungu et al., 2023). Most of these insects are eaten in western Kenya (Ayieko et al, 2010; Ayieko et al, 2012; Kinyuru et al, 2010; Kinyuru et al, 2012, Wanjala et al, 2023). In some parts of western Kenya, such as Vihiga, also alate termites are popularly eaten (Anyuor et al., 2021), either raw or processed (sun-dried/fried) during the rainy season (Alemu et al., 2017a). Typically, women aged 18 to 56 years or more are known to engage in harvesting and preparation of termites (Vugutsa et al., 2022). Therefore, women's habit of eating insects is expected to evoke positive reactions, as also found by Alemu et al. (2017a) and Motoki et al. (2020).

Entomophagy can play an important role in meeting daily nutrient requirements (Orkusz, 2021), as the inclusion of insects in the human diet may reduce the burden of common micronutrient deficiencies such as iron, vitamin A and zinc (Stull, 2021). Despite the nutrient-rich biomass (proteins, fats, minerals, vitamins, and others) of edible insects (Ojha et al., 2021) and their potential to be used in food systems, millions of adults and children worldwide continue to suffer from hunger and malnutrition (GNR, 2022). In 2020, 149 million children under 5 years of age worldwide were stunted (low height for age) and 45 million were wasted, while about 45% of deaths in low- and middle-income countries were due to undernutrition (WHO, 2021). These children typically rely on plant- and cereal-based complementary foods from maize, millet and sorghum, which are low in protein and micronutrient density. This calls for specific interventions aimed at curbing micronutrient deficiencies in infants and young children (IYC) while supporting balanced energy-protein intake and complementary feeding (IFPRI, 2015). To improve the use of edible insect-derived products, it would therefore be more appropriate to integrate them into complementary foods (Tan & House, 2018), e.g., in the form of insect-based instant porridge.

Despite their nutritional value, insect-based products require sensory evaluation to assess their market potential. For example, in a study by Agbemafle et al. (2020), porridge made from orange-fleshed sweet potato (OFSP) and cricket or palm weevil larvae were evaluated by mothers for its sensory properties under blinded conditions, resulting in a rather neutral liking. Musundire et al. (2021) developed an instant termite-millet porridge and characterised its sensory properties, concluding that the liking was high to very high, despite its unfavourable stickiness in the mouth and strong termite flavour. Shabo et al. (2022) produced an extruded composite flour enriched with long-horned grasshoppers and tested the porridge for sensory acceptability. The study found that porridges containing higher levels of extruded long-horned grasshoppers resulted in increased hedonic responses for colour but decreased for aroma and taste. Other studies that investigated the sensory properties of porridge enriched with edible insects included maize enriched with Moringa oleifera leaves and termites (Netshiheni et al., 2019), teff, maize and bee larvae (Mekuria et al., 2021), grain amaranth, maize, fish and termites (Konyole et al., 2012 and Kinyuru et al., 2015) and a composite of maize, wheat, and defatted soybean enriched with cricket flour (Aboge et al., 2021), highlighting the importance of sensory evaluation for the development of insect-based complementary foods.

All the aforementioned studies investigated the potential of insect-based porridge for IYC based on a blind experimental condition, without providing respondents with any information on the health benefits and composition. However, extrinsic cues such as information about the content, brand and packaging are known to influence sensory evaluation and thus food product choice (Piqueras-Fiszman & Spence, 2015). For insect-based foods, research has shown that previous consumption, taste exposure and information influence consumer acceptance (Giotis & Drichoutis, 2021). Schouteten et al. (2016) found that informing consumers that a product was made with insects led to an increase in overall liking for the product.

In addition to sensory properties, also measuring emotional conceptualisations has gained importance in consumer research on novel products. This could provide additional insights beyond acceptability and improve food choice prediction (Gutjar et al., 2015, Schouteten et al., 2018). For insect-based foods, the inclusion of emotions is even more important. Feelings of disgust, i.e., reluctance to eat novel foods such as insect- based foods (Powell et al., 2019), can alter sensory evaluation of insect-based foods (Powell et al., 2019) and are often seen as strong barriers of consumption (Sogari et al., 2023). However, in regions where insects are consumed regularly, positive impacts could also be observed. For example, Pambo et al. (2018a) found that information about buns with cricket flour (CFC) positively influenced consumers' sensory evaluation and emotions of the product.

Most studies on insects and insect-based foods in which the information effect has been tested have been conducted among people living in Western, educated, industrialised, rich and democratic (WEIRD) nations such as Europe and the United States, known as WEIRD subjects or samples (Henrich et al., 2010, Muthukrishna et al., 2020). Insect-based studies with informational implications for WEIRD samples have typically been conducted on adults (Schouteten et al., 2016, Giotis & Drichoutis, 2021) and children (Collins et al., 2019, Dupont & Fiebelkorn, 2020, Chow et al., 2021, Hémar-Nicolas et al., 2022, Erhard et al., 2023). Our study goes beyond the WEIRD samples by targeting Kenya and Western Kenya in particular. One Kenyan study investigated the effect of information on sensory evaluation of insect-based foods in children (Homann et al., 2017), another in children and caregivers (Kinyuru et al., 2021) and a few in adults (Alemu, et al., 2017a, and Pambo et al., 2018b). Only one study investigated the effect of information on emotional conceptualisations of insect-based foods among non-WEIRD Kenyan children's samples (Pambo et al., 2018a). Most studies conducted in Kenya did not examine the effect of information on sensory evaluation and emotional conceptualisation of insect-based foods such as Konyole et al., (2012) and Kinyuru et al., (2009).

This study aims to assess and compare the sensory evaluation of four insect-based instant porridges and a control instant porridge by mothers with children aged 6-23 months in western Kenya. Using a between-subjects study design, the aim is to determine the potential effect of providing information about the health benefits and composition of the instant porridges on sensory evaluation and emotional conceptualisations by consumers.

2. Methodology

2.1. Experimental design and data collection

2.1.1. Development of instant porridges

Five different formulations were prepared and tested in this study. All formulations were prepared with local ingredients that include grain amaranth (*Amaranthus hypochondriacus*) as the main staple food, biofortified OFSP with higher beta-carotene content (*Ipomoea batatas*

(L.) Lam.) and ripe mango fruit (*Mangifera indica* L.). There was one formulated porridge product which served as "control" (i.e. without insects) and four porridge products containing processed (de-winged, oven-dried and ground) grasshoppers (*Ruspolia differens*) or termites (*Macrotermes subhylanus*) meal. Whole milk powder was added to prepare the control formulation (M = milk) and two insect-based formulations, i.e., one from grasshoppers (GH+M) and one from termites (TM +M). In the other two insect-based formulations, no milk powder was added to either the grasshoppers (GH) or the termites (TM) porridges. All ingredients were locally sourced from villages in western Kenya, except for grasshoppers which came from the forests of Masaka in Uganda.

The Linear Programming Module of the Nutrition Surveys and Assessment (NutriSurvey, 2010) was used to develop the different insect-based formulations. Each porridge was developed to meet at least 50% of energy, ≥ 45% of energy from carbohydrate and 50-100% of the recommended nutrient intakes (RNI) for children for protein, total fat, carbohydrate, iron, zinc, calcium and retinol equivalents as recommended by WHO (2002) and GAIN (2014). The formulations were primarily developed to supplement the diets of children aged 6-23 months in western Kenya, and the cost of the formulation was estimated at ≤ 200 KES (~1.5 USD).

All five porridge were precooked by heat extrusion at the Kenya Industrial Research and Development Institute (KIRDI). Only two ingredients, namely cleaned grain amaranths and oven-dried insects, were extruded and the extrudates were then ground into fine flour. The remaining powdered ingredients (OFSP, ripe mango fruit and whole milk powder) were added in varying proportions. The flours were packaged and labelled. Detailed information on the composition and nutritional content of the instant porridges can be found in Table S.1, while information on the nutritional value of the insects can be found in Wambui et al. (2022). Compared to all contemporary local ingredients, all insects used in the formulations contained on average more iron (11.57±2.19 mg/100g dm), zinc (8.23±0.97 mg/100g dm), protein (43.29±5.61 g/100g dm) and fat (52.16±4.86 g/100g dm). From this, we can conclude that the insects used in the current study are good sources of iron, zinc and protein, which were moderately digestible (mean %Fe solubility 29.89±4.30%; %Zn solubility 58.15±4.86%; protein %invitro-protein digestibility 73.56±1.04%) and therefore can be promoted as good sources of iron, zinc, protein and fat in the diet of children aged 4-36 months. For all other ingredients, the mean values for protein (13.03±9.35 g/100g dm), fat (8.09±9.09 g/100g dm), iron (3.63±3.45 mg/100g dm) and zinc (2.04±0.73 mg/100g dm) were lower. Therefore, edible insects can be combined with other ingredients to form a weaning food. Microbial analysis was carried out for all cooked porridges at the Kenya Bureau of Standards. The results confirmed that the porridges were safe for consumption by children under 5 years of age.

2.1.2. Preparation of the porridge for the sensory testing

To prepare 4 cups of instant insect porridge, 4 cups of lukewarm water were poured into a saucepan, then 8 heaped tablespoons (200 g) of instant porridge flour were added, stirring vigorously to avoid lumps. The pot was placed on a gas stove fire and brought to a boil, stirring constantly. Once the instant porridge boiled, it was simmered for 5 minutes. Finally, the porridge was removed from the fire and placed in a warm water bath at 37°C while being served (Kikafunda et al., 1998, Akande et al., 2017).

Sufficient samples of all formulated insect-blends of complementary instant porridges were prepared at the test site early in the morning each day and kept warm in a 37°C water bath (preheated). The samples were served hot in ceramic cups and each cup contained about 30 g of porridge. All cups containing the porridge were labelled with three-digit random numbers and presented for evaluation in balanced order using a Williams' Latin Square design (MacFie et al., 1989).

2.1.3. Participants

The study was conducted in different households in western Kenya, particularly in Khwisero County, which is known for eating edible insects (Ayieko et al., 2010, Kinyuru et al., 2013, Alemu et al., 2015 and Pambo et al., 2016a). Khwisero is a suitable place where alate termite insects are commonly collected, eaten and sold in local markets, but not grasshoppers. In addition to insects, Western Kenyan diets rely on maize, millet and sorghum flour, rice, potatoes, wheat products, eggs, cow and goat milk, fruits and root vegetables (tomatoes, onions), small fish (dagaa) and other fish species, fruits (avocado, mango), starchy roots and plant foods (cassava, sweet potato), legumes (beans) and green leafy vegetables (kale)(Ferguson et al., 2015). Traditional vegetables that are commonly consumed include leafy amaranth, spider plant, jute mallow, crotalaria, Ethiopian kale, African nightshade, cowpea leaves, pumpkin, water spinach, cocoyam, grain legumes, amaranth seeds, and meat (Woomer & Imbumi, 2003).

Community Health Volunteers (CHVs) working in four research sites (Kisa North, Kisa West, Kisa Central and Kisa East) visited households and recruited mothers of reproductive age for sensory assessment (Table S.2). Only mothers who had a child under 24 months of age and consumed edible insects were eligible for participation. A total of 337 participants completed the entire experiment and were included in the data analysis. The researcher and the three trained research assistants pre-tested the questionnaires in a town neighbouring the study area. The questionnaires were administered in the Luhya language and, where possible, only in Swahili. A total of 8 mothers/caregivers were invited for pre-testing the questionnaires. containing demographic information and a sensory and emotional assessment of the samples. After the pre-testing, the questionnaires were adapted accordingly to ensure that the respondents understood the questions well in the local languages.

Socio-demographic information about the participants can be found in Table 1. The mean age of the women was 29 years old. The majority of participants were married (80.4%), earned less than KES 10,000 (~USD 75) (95%) and had only a primary school level of education (56.7%). Most women (41.8%) ate edible insects every week (while in season) and the average age of their child was about 13 months. No significant differences were found between control and informed participants in marital status (p=0.178), employment (p=0.544), income (p=0.448), education (p=0.895), responsibility for food purchase (p=0.963), frequency of insect consumption (p=0.061) and household characteristics.

[Table 1]

2.1.4. Evaluation of the instant porridges

The consumer tests were carried out on 4 samples of insect-based porridges and one 'control' sample with participants evaluating all five samples in a single session. The evaluation was done on a table in large, well-ventilated and well-lit tents or under the canopy of shady trees in the open, mainly in local dispensaries or churches. The tables were placed far away from each other in small booths in the tents or rooms, so that communication between the participants was impossible. One researcher was present at each table to conduct the interview. Figure S.1 contains some field photos from the experiment.

First, mothers were asked if they would be willing to consume insects or insect-based foods (Orsi et al., 2019, Schäufele et al., 2019, Giotis & Drichoutis, 2020) in order to participate in the study. When they agreed and filled in the consent form, they were asked about their socioeconomic profile (marital status, employment, monthly income, education level, household size, age of child; see Table S.2), which was followed by the sensory assessment.

To study the impact of information, half of the participants were told the following about the benefits of insect-based porridge: “Some of the porridge you are about to evaluate contain termites or grasshoppers and are protein-rich porridge blended with cereals, tubers, and vitamin A-rich vegetables with or without powdered milk to create a protein-rich, nutrient-dense porridge unlike the regular porridge flour found on the shelves.”. Participants of the “informed” group also received information about the composition (ingredients) and nutritional value of each porridge. At the end of the study, all participants were rewarded with 400 g of an insect-based instant porridge flour blend.

The sensory evaluation procedure was similar for both groups (control and informed) and consisted of 3 steps for each sample. First, the liking (overall liking, aroma, flavour and mouthfeel) was assessed using a 9-point labelled hedonic scale (ranging from 1= dislike extremely to 9= like extremely), followed by a sensory profiling and an emotional profiling task. For sensory profiling, participants performed a just-about-right task (JAR) that included 8 sensory attributes (adhesiveness, dark colour, fishy aroma, fishy flavour, glossiness, nutty mouthfeel, thickness and viscosity) (Mishyna et al., 2020). Finally, participants were instructed to rate the intensity (Rate all that apply (RATA) scale: 0 = not present, 1= low, 2 = medium, 3 = high) of the emotions they perceived after eating each sample using the EsSense25 list (Nestrud et al., (2016)).

The questionnaire comprised 4 parts as described in the questionnaire flow in Figure 1.

[Figure 1]

2.2. Data analysis

All data collected were entered into IBM SPSS Statistics (version 25). Various profiling variables were created as dummy variables (Diaz et al., 2021), i.e., frequency of eating insects during the season was transformed into 'less' (eaten at least once a month and once to rarely) and 'more' (eaten every day and every week). Pearson's chi-square tests for equality of proportions and counts of ticked socioeconomic attributes for each rater in control and informed conditions were used to determine the association between rater and conditions. Chi-square results for marital status, income, education, responsibility for food purchases and frequency of insect consumption were obtained. Independent-samples T-tests were used to examine the mean values of household characteristics between the two conditions (control/informed).

Data on overall liking (Ribeiro et al., 2022), JAR (Ohlau et al., 2023) and emotions (Gurdian et al., 2021) were analysed in SPSS using a two-way mixed analysis of variance (ANOVA) for all 5 instant porridges to determine if the porridges were rated differently. Sample, experimental condition (control and informed) and their interaction were considered as fixed sources of variation (Reis et al., 2017). Tukey's test was used for post-hoc analysis in SPSS. Independent-samples T-tests were used to examine the mean scores of likings, JAR and emotions between the two conditions (control/informed) (Schouteten et al., (2016)). The previous analyses were conducted in SPSS, while XLSTAT version 2023.1.4 (Lumivero, 2023) was used to conduct a penalty analysis (mean drops vs. %) with multiple comparisons (Ohlau et al., 2023).

3. Results

3.1. Consumer liking of the instant porridges

The mean scores for liking as rated by the participants can be found in Table 2. There was a significant (F(4, 13.115)=3.243; p=0.012) interaction effect between the experimental condition and the type of instant porridge on overall liking. This indicates that the information effect differed between the instant porridges. Information affected only the overall liking score of GH+M, with the mean overall liking being significantly (t(331)=2.451, p=0.015) higher during the control (7.8) than during the informed conditions (7.2). Under control conditions, mean overall liking score of TM was significantly higher (F(4, 29.128)=7.201, p<.001) than of GH (p<.001) and M (p<.001), while under informed conditions the mean overall liking score of TM+M was significantly higher (F(4, 15.722)=3.887, p=0.004) than GH (p=0.003) and GH+M (p<.001).

Furthermore, a significant interaction effect was found for liking of the aroma (F(4, 8.269)=2.773, p=0.026), suggesting that the information effect differed according to the instant porridges. Information only affected liking of the aroma for GH+M, with the mean liking being significantly (t(333)=2.84, p=0.005) higher during the control (8.1) than during the informed condition (7.5).

There was also a significant effect of information (F(1, 14.010)=4.549, p=0.033), (F(1, 23.317)=7.778, p=0.005) and type of porridge (F(4, 12.063)=3.917, p=0.004), (F(4, 16.336)=5.449, p<.001) on liking for flavour and mouthfeel respectively. The liking scores of GH+M for flavour (t(331)=2.555, p=0.011) and mouthfeel (t(332)= 3.455, p<.001) were significantly higher in the control than in the informed condition. Regarding the influence of the type of porridge, the mean liking score for flavour was significantly lower (F(4, 12.063)=3.917, p=0.004) for the control porridge M (7.5) than for the two porridges enriched with termites (TM and TM +M). Also the average liking of the mouthfeel was significantly lower (F(4, 16.336)=5.449, p<.001) for the control porridge (M) than for termite porridges. For GH, the average liking of the mouthfeel (7.7) was significantly lower (F(4, 16.336)=5.449, p<.001) than for TM +M (8.1).

[Table 2]

3.2. Sensory profiling

There was a significant interaction effect between the experimental condition and the type of porridge on the JAR ratings of adhesiveness (F(4, 4.781)=2.862, p=0.022), dark colour (F(4, 2.244)=2.447, p=0.045), and thickness (F(4, 5.698)=6.096, p<.001). In other words, information had an impact on the average JAR ratings of these attributes, but the impact differed between instant porridges. The average scores of the JAR rated by the participants can be found in Table 3. It should be noted that the average score of 3 corresponds to the ideal value with all porridges displaying a too low intensity for fishy aroma and fishy flavour next to too little nutty mouthfeel. Detailed information on the percentages for the JAR levels in porridges under experimental conditions can be found in Figure S.2

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[Table 3]

3.3. Penalty analysis

The penalty analysis performed on the liking and JAR data of the different samples is shown in Figure 2. None of the JAR attributes for TM were significantly penalised by respondents under both conditions. In general, fishy aroma and/or flavour were considered to be present, albeit too little in most of the instant porridges. However, under the both conditions, fishy flavour was penalised as not to be present in TM+M (control; *p*=0.0001, informed; *p*=0.021). Different types of instant porridge were penalised for fishy aroma and flavour, either under both conditions (GH (control; *p*<.0001, informed; *p*=0.003) and GH+M (control; *p*=0.001 informed; *p*=0.007) or only the control condition in MO (*p*<.0001). Regarding colour, participants considered different porridges to be much too dark, namely M (*p*=0.001, TM+M (*p*=0.0003) and GH+M (*p*=0.031) in the control condition. Other attributes penalised under control condition as being too strong were glossiness in TM+M (*p*=0.022) and GH+M (*p*=0.004), adhesiveness in GH (*p*=0.044) and GH+M (*p*<.0001) and a smooth mouthfeel in TM+M (*p*=0.009) and GH (*p*=0.0001). Too little graininess was penalised in both TM +M (*p*=0.003) and GH (*p*=0.006) under control condition. Thickness was penalised as to be too much in GH+M (control; *p*=0.004). Detailed information on mean reduction of JAR levels in porridges under each experimental condition can be found in Figures S.3 and Table S.3.

[Figure 2]

3.4. Emotional profiling

The mean scores of the emotions elicited by the instant porridges can be found in Table 4. Nineteen out of 25 emotions were significantly influenced by the experimental conditions (active, adventurous, aggressive, calm, enthusiastic, free, good-natured, happy, interested, joyful, loving, mild, nostalgic, pleasant, satisfied, secure, tame, warm and wild). In general, providing information had a negative impact as it resulted in a lower average intensity of positive emotions. TM +M and TM had typically the highest scores for positive emotions, while M had in some cases (e.g. happy, interested) lower scores.

A significant interaction effect between the experimental condition and the type of porridge was only found for the emotion “Good” (*F*(4, 2.729)=2.627, *p*=0.033), which means that the effect of the information differed according to porridge type. Participants rated the intensity of the emotion “Good” significantly higher (*t*(328)= 2.703, *p*=0.007) after tasting GH+M under control conditions (2.6) than under informed conditions (2.3). Under control conditions, the intensity of the emotion “Good” did not differ significantly for porridge type, but under informed conditions (*F*(4, 3.257)=2.993, *p*=0.018), it was rated significantly lower for GH (2.26), and significantly higher for TM (2.60).

[Table 4]

4. Discussion

To the authors' knowledge, this is the first non-WEIRD sample study to examine how nutritional information impact consumer sensory and emotional evaluation of newly developed insect-based complementary porridges. This study found that information had a negative significant effect on the overall liking, liking of the aroma, flavour and mouthfeel of the GH+M sample, but no significant effect on the other insect-based porridges or the control sample. However, information had a positive significant effect on participants appreciation of sensory attributes such as adhesiveness, nutty mouthfeel and thickness of insect-based instant porridges. In addition, the provision of information had a limited, albeit negative, influence on the emotions evoked by some types of instant porridge.

There was an interaction effect between the experimental condition and the type of instant porridge on the overall liking scores of the porridge, albeit only for one sample (GH+M). This is in contrast to a WEIRD sample study by Schouteten et al. (2016), in which information about the composition of insect-based burgers positively influenced the overall acceptability of insect-based burgers under blinded, expected and informed conditions. One possible reason for this could be that Schouteten et al. (2016) worked with a WEIRD sample and tested a different product category (burgers). In the present study, overall liking scores of one instant porridge of grasshoppers with milk powder (GH+M) was significantly higher under the control condition than under the informed condition. When the informed participants in this part of the Kenyan non-WEIRD population knew that grasshoppers were part of the porridge, they scored it lower for overall liking, which might be due to the fact that grasshoppers are not part of the Khwisero food habits, unlike eating termites (Vugutsa et al., 2022). The negative effect of providing information was rather surprising and is not consistent with previous research that found that providing information on edible insects and benefits of eating insect-based foods leads to higher acceptance of indirect entomophagy (Giotis & Drichoutis, 2021). In their study on the Greeks, Giotis & Drichoutis (2021) found that the low acceptance of insects and insect-based foods among WEIRD consumers is driven by unfamiliarity. Our findings might be due to the low level of education in the study population. Comparison with the education level in studies in adjacent regions lends support for our relatively low education levels (Ondiba & Matsui, 2019; Alemu, et al, 2017a), which might have affected the understanding of the value of information on the health benefits and composition of instant porridges.

This study found that the overall liking of instant porridge was significantly influenced by the type of porridge. Overall liking of all instant porridges of termites without (TM) and with milk powder (TM +M) was significantly higher than the sample made with grasshoppers without milk powder (GH) and the control instant porridge without insects (M). These results are in line with those of Musundire et al. (2021), a Zimbabwean sample, and Konyole et al. (2012), a Kenyan sample, who reported high acceptance of termite-enriched porridge. In addition, the results also confirm the findings of Shabo et al. (2022) on the overall acceptability of the instant porridge mixed with grasshoppers by Tanzanians, where no significant difference was found between the porridge mixed with grasshoppers and the control instant porridge, even though the participants were informed about the ingredients of the porridge. A study by Alemu, et al. (2017a) in Kenyan sample, found that product-related attributes of termite products are only important if the product is also recommended by friends, relatives, peers, media, etc (Werunga et al., 2022). In this study, some limited information about the benefits of insect-based porridge was provided to half of the participants.

Finally, the culture of the Khwisero people, who eat termites rather than grasshoppers, may have influenced the outcome of our study. Other studies have also reported challenges associated with eating insects that are unfamiliar to a given WEIRD and non-WEIRD population. Hartmann et al. (2015), who compared insect consumption in WEIRD samples of Germany and in China, reported that foods that are familiar and valued by a community, e.g previous experience with the consumption of certain insects, can influence acceptance in that particular culture, as has also been found in many Kenyan non-WEIRD samples (Alemu et al., 2017b, Alemu & Olsen, 2020, Pambo et al., 2016a, Pambo et al., 2018a, Pambo et al., 2018b, Kusia et al., 2021). In the current study, consumption of termite-enriched porridge might be more acceptable than consumption of grasshopper-enriched porridge because acceptability might be higher when the origin of the insect is known and equally important.

The result of this study shows that grasshopper-enriched porridge is less accepted in Khwisero, even when it is processed into complementary instant porridge. Our study hypothesised that despite the fact that grasshoppers are not commonly consumed in Khwisero, they would be accepted as processed products because a study by Lombardi et al. (2019) in Italian WEIRD samples found that processed insect-based foods, where the insect is not visible, were favoured. However, in this Kenyan study, familiar insects were preferred in porridge. Among the Khwisero, termites are usually eaten whole, either raw or processed (sun-dried/fried and salted), and this was the first time that termites were processed into complementary flour among this sample of non-WEIRD termite consumers. Alemu et al (2017a) reported that whole or processed termites (sun-dried/fried and salted) were equally accepted in parts of western Kenya. However, most Kenyan consumers prefer to consume the insects rather whole than in processed form (Mulungu et al., 2023). This is often the case in non-WEIRD samples as they typically appreciate the taste of whole insects eaten as a snack (Awobusuyi et al., 2020). In WEIRD samples, the acceptability of whole insects was found to be low, as shown in studies from Poland (Bartkowicz & Babicz-Zielińska, 2020), the Czech Republic (Kulma et al., 2023), Ireland (Kane & Dermiki, 2021), Germany (Orsi et al., 2019), Denmark (Erhard et al., 2023) and the USA compared to Indian non-WEIRD samples (Ruby et al., 2015). In Asian non-WEIRD samples, however, whole insects face lower barriers, as shown in Taiwan (Seekings & Wong, 2020).

In general, the informed group scored significantly higher values that were closer to JAR (mean value of 3) on termite-enriched porridges for adhesiveness, thickness and nutty mouthfeel than grasshopper-enriched porridge and the control instant porridge without insect. This may be attributed to the fact that consuming grasshoppers in large quantities is not a customary practice in Kenyan culture, particularly in Khiwisero County, except in a few regions along the Kenya-Uganda bother. Grasshoppers are abundantly offered and sold in markets in Uganda (Olum et al., 2021), but not in Kenya, which may have influenced the informed participants' decision. While Kenyans mainly consume termites, in some parts of western Kenya both termites and grasshoppers are traditionally more popular (Ayieko et al., 2010, Kinyuru et al., 2010). The latter might be related to past experiences and current beliefs regarding edible insect consumption as observed in Kenyan non-WEIRD samples (Ayieko et al., 2010, Kinyuru et al., 2010), as well as in WEIRD samples such as Finland, Sweden, Germany and the Czech Republic (Looy et al., 2014, Piha et al., 2018).

All instant porridges, were penalised on several attributes under the control condition, but mainly the intensity of the fishy flavour and aroma were perceived as too low under the control condition, though information provision improved the perceptions of these JAR attributes in porridges. Both termites and grasshoppers could have caused a fishy flavour and aroma (Mishyna et al., 2020), which can be avoided by the Maillard reaction during roasting of insects and extrusion cooking of the instant porridges (Żołnierczyk & Szumny, 2021). A higher penalization of grasshopper-enriched porridge (GH and GH+M) might be attributed to the unfamiliarity of eating grasshoppers in this region (Ayieko et al., 2010). Termites are known to have a nutty mouthfeel (Igwe et al., 2012) but this was not penalised more in the porridge made with termites. The grainy texture, dark colour and smoothness of the porridge are achieved through extruded pellets. Extruded porridge tends to be somewhat thick (Akande et al., 2017), hard (Igual et al., 2020), adhesive (Mosibo et al., 2022) and dark brown in colour (Alam et al., 2019). Extrusion cooking of insect-based foods is mostly reported in WEIRD sample studies such as in Spain (Igual et al., 2020) and Italy (Alam et al., 2019, Mosibo et al., 2022). Similar to our study, Akande et al. (2017) extruded amaranth-based porridge and also found that the thickness scores of the amaranth porridge were significantly higher than those of the control porridge. For the current instant porridges, it will be important to improve the penalised attributes and promote the pleasant flavours and colours, which are shown to be important for product development (Pambo et al., 2018a). Although the consumption of small fish is common in Kenya (Kinyuru et al., 2015), the addition of small fish, commonly known as dagaa fish, to porridges for babies is not always appreciated. In western Kenya, dagaa fish has been used in the preparation of complementary foods. However, when Konyole (2012) added dagaa fish and termites to porridge, it was much less accepted because of its colour and smell.

In general, the intensity of various positive emotions for the different types of instant porridge was higher in the controlled group. These results are consistent with the emotional evaluation of cricket-based buns, where a similar slight difference was found between the informed and control groups (Pambo et al., 2018a). However, similar to Pambo et al. (2018a), our two groups also rated generally positive feelings when tasting the insect-based instant porridges. Pambo et al. (2018a) assessed the role of information about cricket flour buns and found that, similar to our study, mainly positive emotions dominated. Further, it was also found that all insect porridges received the high average intensities of positive emotions. Despite the fact that cowmilk is one of the common ingredients in complementary porridge (Bwibo & Neumann, 2003, Mbagaya, 2009, Kinyuru et al., 2021, Kimiywe et al., 2022), the highnaverage intensity of positive emotions for termite and grasshopper porridge with cowmilk powder cannot be attributed to the addition of milk alone, but is likely to be related to both insects in combination with milk powder, a combination that has not been investigated in a complementary porridge so far. Our finding is confirmed by the fact that termite and grasshopper porridge without milk powder also received high ratings. It was also found that the participants in our study rated the negative emotions used to describe a porridge very low. In a WEIRD sample from Switzerland, Gmuer et al. (2016) investigated the role of emotions in the consumption of cricket products and found that, similar to our study, positive emotions were dominant although participants did not taste the samples. The Khwisero sub-county (the churches and dispensaries) was a suitable location for the mothers to taste the insect-based porridges as this may also have evoked positive emotions as previously observed by Alemu et al. (2017a) in Kenya non-WEIRD samples and Motoki et al. (2020) in Japanese WEIRD samples. This suggests that insect-based foods, combined with public awareness of their nutritional value, enjoy a high level of acceptance in the relevant study populations and therefore have a high potential for commercial expansion as a complementary food for children under 5 years of age and could help to address the existing problems of micronutrient malnutrition.

There was only a significant interaction effect between the experimental condition and the type of porridge on only the emotion "good" of the porridge. In the present study, the emotion "good" of one instant porridge made from grasshoppers with milk powder (GH+M) was significantly higher under the control condition than under the informed condition. This study found that the emotion "good" of instant porridge was significantly influenced by the type of porridge. The emotion "good" of the instant porridge of termites without milk powder (TM) was significantly higher than that of grasshoppers without milk powder (GH) under informed condition. The current results on emotions are also consistent with a study by Schouteten et al. (2016) among a Belgian WEIRD sample, in which information about the ingredients of insect-, plant- and meat-based burgers had little impact on emotional conceptualisations. Under control conditions, participants scored the emotion attribute "good" (2.63±0.88) highly for grasshopper-enriched porridge, whereas under informed conditions, participants scored the emotion attribute "good" (2.60±0.93) highly for termite-enriched porridge. We have linked this to the fact that participants are familiar with eating termites and it is socially accepted. Regardless of the taste and information about the health benefits and composition of grasshopper-enriched porridge, they find it less favourable than termites, which is consistent with Hartmann et al. (2015) who compared the psychology of eating insects in WEIRD samples of German and also among the Chinese in a study. In our study, the information about the health benefits and composition of insect-based instant porridges generally did not seem to make a big difference between termite-enriched and grasshopper-enriched porridges in terms of emotional conceptualisations. Our study concludes that information about the health benefits and composition of eating grasshopper-enriched porridge compared to termite-enriched porridge did not substantially increase mothers' evaluation. In line with Hartmann et al. (2015), the perceived nutritional value of insects and insect-based foods is not the main obstacle to overcome. Alemu, et al. (2017a) who studied non-WEIRD samples also reported that Kenyan consumers also appreciated termite-based foods, whether whole or processed, with or without high nutritional value. In their study, consumers had positive reactions to termite products because they were presented with foods that they were familiar with and that are commonly consumed in western Kenya. In addition, participants in their study reported that they had tasted termites before but had moved to the city, although they still had positive experiences with the taste. Mulungu et al. (2023) investigated insect consumption behaviour in a study in western Kenya and found that culture explained the preference for eating insects and that termites were the most popular.

To summarise, literature on insect-based foods that have examined information effects found both positive and negative effects in WEIRD populations as well as in non-WEIRD insect consumers. In non-WEIRD samples, for instance, a study of Pambo et al. (2018a) showed a negative information effect for sensory evaluation, but a positive effect for emotional conceptualisations. A similar information effect on sensory evaluation was reported by Homann et al. (2017), also in a Kenyan non-WEIRD study. A few studies targeting the WEIRD samples showed that information about the composition of insect-based foods positively influenced the overall acceptability of insect-based foods, similar as in a Belgian (Schouteten et al., 2016) but negatively in a Greek study (Giotis & Drichoutis, 2021). However, some WEIRD sample studies showed a lack of intervention effect, as was the case for the Danish WEIRD sample in the study of Erhard et al. (2023).

This study has some limitations. First, possible social interactions with the participants at the locations and in the neighbourhoods where the study was conducted could have influenced their sensory evaluations (Hersleth et al., 2005). Second, our study focused specifically on western Kenya, where edible insects are commonly collected, consumed and sold. Extending the target region to other regions and countries would allow to assess how fewer familiar women would evaluate insect-based products for their children. Future studies could also attempt to better understand sensory evaluation of porridge by the children (aged 6-23 months) themselves (Konyole et al., 2012). Third, we chose not to brand or package the insect-based flours. As such promotion efforts could also influence acceptance, future studies could evaluate how to improve the marketing of insect-based foods, e.g., through different packaging materials, and influence consumer evaluation, as was done with Kenyan non-WEIRD consumers (Kamau et al., 2018), and among WEIRD consumers in Sweden (Elhassan et al., 2019), Denmark (Kauppi, 2020), Germany (Naranjo-Guevara et al., 2023) and Italy (Pozharliev et al., 2023). Fourth, in the study population, overall liking of insect-based instant porridge might be influenced by various factors, such as cultural beliefs, as observed in Italian WEIRD samples (Tuccillo et al., 2020), level of education and other socio-demographic factors in both non-WEIRD (Pambo et al., 2016b) and WEIRD samples (Tan et al., 2017). Lastly, a unique aspect of this non-WEIRD sample is that termites are collected seasonally in the wild in Khwisero and it is difficult to rear them on farms. Therefore, it may be equally challenging to have a locally year-round supply of termite-enriched porridges in the off-season (Alemu et al., 2017a).

This study addresses the need for more sensory consumer research on insect-based foods in non-WEIRD and WEIRD samples (Hartmann & Siegrist, 2017, Tan et al., 2017, Mancini et al., 2019), the results of which will help to better assess the market potential of insect-based porridge for children. However, promoting insect-based complementary food requires not only providing information on the porridges, but also educating mothers on the value of feeding children nutritious foods to address the problems of malnutrition in infants and young children. The fact that the insect-based instant porridges showed in general high overall liking scores and elicited primarily positive emotions suggests that insect-based porridges have market potential in the study region.

CRediT authorship contribution statement

Maryam Imbumi: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Software, Visualization, Roles/Writing original draft, Writing – review & editing. **Joachim J. Schouteten**: Formal analysis, Methodology Software, Validation, Visualization, Writing – review & editing. **Sheila Okoth**: Supervision, Writing – review & editing. **Chrysantus Mbi Tanga**: Supervision. **Katleen Raes**: Funding acquisition & Supervision. **Xavier Gellynck**: Funding acquisition, Resources & Supervision. **Judith Kimiywe**: Funding acquisition, Project administration & Supervision. **Hans De Steur**: Conceptualization, Funding acquisition, Project administration, Resources, Software, Supervision, Validation, Writing – review & editing.

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Supplementary material

Supplementary data to this article can be found online

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TABLES

Table 1. Sociodemographic characteristics of the sample (n=337)

Characteristic	Category	CONTROL (n=168)	INFORMED (n=169)	TOTAL SAMPLE (n=337)
		x̄ ± SD	**x̄ ± SD**	**x̄ ± SD**
Age	Age of mother (years)	30.08±8.80	28.11±7.41	29.09±8.18
	Age of child (months)	12.99±5.22	13.41±5.70	13.20±5.46
		% of sample	**% of sample**	**% of total sample**
Marital status	Married	83.3%	77.5%	80.4%
	Unmarried	16.7%	22.5%	19.6%
Employment	Employed	43.5%	46.7%	45.1%
	Unemployed	56.5%	53.3%	54.9%
Individual income (Monthly KES)	0-10,000	94.0%	95.9%	95.0%
	>10,000	6.0%	4.1%	5.0%
Level of education	Non completed	6.5%	9.5%	8.0%
	Primary school	58.3%	55.0%	56.7%
	Secondary school	27.4%	27.2%	27.3%
	Tertiary (college)	7.1%	7.7%	7.4%
	University level	0.6%	0.6%	0.6%
Food purchase within household	Responsible	41.7%	41.4%	41.5%
	Not responsible	58.3%	58.6%	58.5%
Insect Consumption	More frequent	60.7%	70.4%	65.6%
	Less frequent	39.3%	29.6%	34.4%
		x̄ ± SD	**x̄ ± SD**	**x̄ ± SD**
Household characteristics	Acres of Land	0.74±0.80	0.82±1.13	0.78±0.98
	Size	5.45±2.12	5.35±1.99	5.40±2.06

Note: KES (Kenyan shillings) 10,000 (~USD 75)

Table 2. Liking scores of insect-based instant porridges (n=337), mean (±SD)

	[1]TM	[2]TM+M	[3]GH	[4]GH+M	[5]M
CONTROL (n=168)					
Overall Liking	8.04±1.45^{cA}	7.70±1.95^{bcA}	7.28±2.22^{abA}	7.77±1.80^{bcA}	6.99±2.47^{aA}
Aroma	8.07±1.40^{bA}	8.11±1.47^{bA}	7.76±1.96^{abA}	8.10±1.36^{bA}	7.36±2.23^{aA}
Flavour	8.17±1.28^{bA}	8.04±1.60^{bA}	7.72±1.96^{abA}	8.08±1.43^{bA}	7.45±2.12^{aA}
Mouthfeel	8.18±1.39^{bA}	8.10±1.66^{bA}	7.79±1.99^{abA}	8.20±1.28^{bA}	7.57±2.06^{aA}
INFORMED (n=169)					
Overall Liking	7.71±2.03^{abA}	7.97±1.54^{bA}	7.32±2.17^{aA}	7.24±2.14^{aB}	7.40±2.12^{abA}
Aroma	7.92±1.59^{aA}	8.01±1.50^{aA}	7.68±1.86^{aA}	7.56±2.01^{aB}	7.71±1.68^{aA}
Flavour	7.83±1.88^{aA}	7.84±1.72^{aA}	7.63±1.86^{aA}	7.61±1.92^{aB}	7.64±1.61^{aA}
Mouthfeel	7.86±1.78^{abA}	8.10±1.42^{bA}	7.55±1.79^{aA}	7.56±2.00^{aB}	7.59±1.74^{abA}

Note: Values in lower case within rows with different superscripts are significantly different ($p \leq 0.05$) and compare specific attributes of different porridges separately under the same condition (control/informed). Values in upper case within columns with different superscripts are significantly different ($p \leq 0.05$) and compare specific attributes of the same porridge between control and informed condition. [1]TM = termites without milk powder, [2]TM+M = termites & milk powder, [3]GH = grasshoppers without milk powder, [4]GH+M = grasshoppers & milk powder, and [5]M = no insects ('control')

Table 3. Mean (±SD) of Just About Right ratings of sensory attributes (control = 168, informed = 169, total n=337).

		[1]TM	**[2]TM+M**	**[3]GH**	**[4]GH+M**	**[5]M**
Adhesiveness	Control	3.08±1.29^{bcA}	3.23±1.28^{bcA}	3.46±1.33^{cA}	3.03±1.33^{bA}	2.15±1.25^{aA}
	Informed	3.43±1.29^{bB}	3.26±1.25^{bA}	3.26±1.26^{bA}	3.30±1.31^{bA}	2.50±1.33^{aB}
Fishy Aroma	Control	2.16±1.26^{aA}	2.12±1.24^{aA}	2.38±1.26^{aA}	2.22±1.24^{aA}	2.02±1.18^{aA}
	Informed	2.26±1.28^{abA}	2.27±1.24^{abA}	2.53±1.29^{bA}	2.46±1.38^{bA}	2.07±1.23^{aA}
Dark Colour	Control	3.16±0.96^{bA}	3.24±0.90^{bA}	3.61±0.96^{cA}	3.10±0.93^{bA}	2.77±0.97^{aA}
	Informed	3.24±0.91^{bA}	3.06±0.96^{bA}	3.24±1.00^{bB}	3.00±1.01^{bA}	2.59±0.96^{aA}
Glossiness	Control	3.26±1.20^{abA}	3.41±1.16^{bA}	3.15±1.33^{abA}	3.27±1.19^{abA}	2.98±1.29^{aA}
	Informed	3.47±1.15^{bA}	3.33±1.11^{abA}	3.35±1.20^{abA}	3.29±1.16^{abA}	3.04±1.23^{aA}
Fishy Flavour	Control	2.27±1.29^{aA}	2.20±1.25^{aA}	2.39±1.29^{aA}	2.35±1.29^{aA}	2.06±1.18^{aA}
	Informed	2.36±1.26^{aA}	2.25±1.24^{aA}	2.45±1.31^{aA}	2.45±1.31^{aA}	2.07±1.16^{aA}
Viscosity	Control	3.51±0.92^{bA}	3.57±1.00^{bA}	3.61±1.16^{bA}	3.35±1.04^{abA}	3.03±1.36^{aA}
	Informed	3.55±1.01^{bA}	3.39±1.05^{bA}	3.32±1.08^{bB}	3.45±1.09^{bA}	2.77±1.31^{aA}
Thickness	Control	3.46±0.91^{bA}	3.45±0.97^{bA}	3.77±1.03^{cA}	3.18±0.93^{bA}	2.03±0.92^{aA}
	Informed	3.72±0.91^{bB}	3.51±0.95^{bA}	3.55±0.99^{bB}	3.58±1.01^{bB}	2.41±1.03^{aB}
Nutty Mouthfeel	Control	2.08±1.26^{aA}	2.10±1.26^{aA}	2.15±1.32^{aA}	2.14±1.30^{aA}	2.08±1.26^{aA}
	Informed	2.53±1.32^{aB}	2.55±1.30^{aB}	2.39±1.26^{aA}	2.40±1.29^{aA}	2.20±1.21^{aA}

Note: Values in lower case within rows with different superscripts are significantly different ($p \leq 0.05$) and compare the average JAR scores of specific attributes of the different porridges separately under the same condition (control/informed). Values in upper case within columns with different superscripts are significantly different ($p \leq 0.05$) and compare the average JAR scores of specific attributes of the same porridge between control and informed conditions.[1]TM = termites without milk powder, [2]TM+M = termites & milk powder, [3]GH = grasshoppers without milk powder, [4]GH+M = grasshoppers & milk powder, and [5]M = no insects (“control”).

Table 4. *RATA results for the emotional conceptualisations after consumers (n=337) tasted the porridge (from the analysis of the means (±SD)).

	CONTROL (n=168)					INFORMED (n=169)				
	[1]TM	[2]TM+M	[3]GH	[4]GH+M	[5]M	[1]TM	[2]TM+M	[3]GH	[4]GH+M	[5]M
Active	2.07±1.19^{Aa}	2.01±1.24^{Aa}	2.08±1.20^{Aa}	2.03±1.24^{Aa}	1.93±1.25^{Aa}	2.21±1.16^{Aa}	2.22±1.19^{Aa}	2.05±1.19^{Aa}	2.09±1.25^{Aa}	2.18±1.16^{Aa}
Adventurous	2.51±1.00^{Aa}	2.52±0.98^{Aa}	2.48±1.01^{Aa}	2.45±1.06^{Aa}	2.44±1.06^{Aa}	2.08±1.36^{Ab}	2.02±1.32^{Ab}	1.98±1.32^{Ab}	1.99±1.38^{Ab}	2.02±1.31^{Ab}
Aggressive	1.25±1.45^{Aa}	1.27±1.45^{Aa}	1.27±1.44^{Aa}	1.32±1.47^{Aa}	1.24±1.44^{Aa}	1.45±1.45^{Aa}	1.40±1.41^{Aa}	1.42±1.42^{Aa}	1.31±1.45^{Aa}	1.49±1.42^{Aa}
Bored	0.15±0.60^{Aa}	0.19±0.68^{Aa}	0.26±0.78^{Aa}	0.18±0.63^{Aa}	0.36±0.91^{Aa}	0.22±0.74^{Aa}	0.19±0.64^{Aa}	0.27±0.84^{Aa}	0.23±0.71^{Aa}	0.24±0.76^{Aa}
Calm	1.95±1.36^{Aa}	1.88±1.39^{Aa}	1.76±1.38^{Aa}	1.77±1.40^{Aa}	1.72±1.39^{Aa}	1.65±1.42^{Aa}	1.55±1.42^{Ab}	1.49±1.38^{Aa}	1.53±1.45^{Aa}	1.54±1.41^{Aa}
Disgusted	0.27±0.83^{Aa}	0.37±0.96^{Aa}	0.34±0.92^{Aa}	0.33±0.88^{Aa}	0.50±1.06^{Aa}	0.22±0.72^{Aa}	0.25±0.78^{Aa}	0.37±0.92^{Aa}	0.27±0.81^{Aa}	0.33±0.84^{Aa}
Enthusiastic	2.30±1.22^{Aa}	2.41±1.14^{Aa}	2.24±1.25^{Aa}	2.30±1.23^{Aa}	2.17±1.28^{Aa}	2.12±1.31^{Aa}	199±1.35^{Ab}	1.91±1.32^{Ab}	1.96±1.36^{Ab}	2.17±1.25^{Aa}
Free	2.46±1.04^{Aa}	2.43±1.09^{Aa}	2.40±1.12^{Aa}	2.47±1.08^{Aa}	2.21±1.20^{Aa}	2.14±1.31^{Ab}	2.10±1.31^{Ab}	1.88±1.33^{Ab}	1.95±1.36^{Ab}	2.08±1.26^{Aa}
Good	2.52±0.98^{Aa}	2.57±0.93^{Aa}	2.42±1.07^{Aa}	2.63±0.88^{Aa}	2.35±1.10^{Aa}	2.60±0.93^{Ba}	2.50±0.99^{ABa}	2.26±1.12^{Aa}	2.33±1.18^{ABb}	2.49±0.98^{ABa}
Good Natured	2.63±0.87^{Ba}	2.68±0.81^{Ba}	2.44±1.08^{ABa}	2.61±0.90^{Ba}	2.30±1.17^{Aa}	2.30±1.21^{Ab}	2.24±1.24^{Ab}	2.18±1.24^{Ab}	2.20±1.26^{Ab}	2.26±1.18^{Aa}
Guilty	0.14±0.60^{Aa}	0.13±0.60^{Aa}	0.15±0.63^{Aa}	0.20±0.71^{Aa}	0.24±0.79^{Aa}	0.16±0.65^{Aa}	0.16±0.66^{Aa}	0.11±0.54^{Aa}	0.19±0.70^{Aa}	0.15±0.64^{Aa}
Happy	2.69±0.76^{Ba}	2.82±0.58^{Ba}	2.58±0.96^{Ba}	2.65±0.88^{Ba}	2.28±1.17^{Aa}	2.41±1.11^{Ab}	2.50±1.01^{Ab}	2.25±1.14^{Ab}	2.33±1.17^{Ab}	2.34±1.11^{Aa}
Interested	2.68±0.78^{Ba}	2.73±0.75^{Ba}	2.57±0.95^{ABa}	2.56±0.95^{ABa}	2.38±1.08^{Aa}	2.53±1.02^{Aa}	2.53±0.94^{Ab}	2.35±1.07^{Aa}	2.31±1.16^{Ab}	2.51±0.94^{Aa}
Joyful	2.55±0.98^{Aa}	2.53±1.01^{Aa}	2.40±1.10^{Aa}	2.54±0.98^{Aa}	2.27±1.16^{Aa}	2.23±1.25^{Ab}	2.21±1.25^{Ab}	1.99±1.26^{Ab}	2.06±1.33^{Ab}	2.15±1.23^{Aa}
Loving	2.62±0.87^{Ba}	2.58±0.91^{Ba}	2.54±0.96^{ABa}	2.60±0.88^{Ba}	2.27±1.13^{Aa}	2.27±1.22^{Ab}	2.24±1.22^{Ab}	2.00±1.26^{Ab}	2.10±1.30^{Ab}	2.16±1.20^{Aa}
Mild	1.11±1.39^{Aa}	1.10±1.41^{Aa}	1.02±1.37^{Aa}	1.20±1.42^{Aa}	1.02±1.35^{Aa}	0.73±1.24^{Ab}	0.74±1.21^{Ab}	0.82±1.27^{Aa}	0.73±1.23^{Ab}	0.70±1.20^{Ab}
Nostalgic	1.59±1.44^{Aa}	1.45±1.46^{Aa}	1.48±1.44^{Aa}	1.51±1.46^{Aa}	1.41±1.41^{Aa}	1.15±1.43^{Ab}	1.12±1.43^{Ab}	1.08±1.37^{Ab}	1.06±1.41^{Ab}	1.10±1.40^{Ab}
Pleasant	2.54±0.98^{Aa}	2.55±0.97^{Aa}	2.44±1.06^{Aa}	2.49±1.03^{Aa}	2.29±1.15^{Aa}	2.24±1.25^{Ab}	2.23±1.21^{Ab}	2.12±1.17^{Ab}	2.25±1.24^{Aa}	2.16±1.26^{Aa}
Satisfied	2.71±0.74^{Ba}	2.60±0.89^{ABa}	2.46±1.03^{ABa}	2.67±0.80^{Ba}	2.34±1.10^{Aa}	2.46±1.05^{Ab}	2.37±1.12^{Ab}	2.28±1.11^{Aa}	2.19±1.24^{Ab}	2.30±1.09^{Aa}
Secure	2.52±0.99^{Aa}	2.39±1.13^{Aa}	2.36±1.12^{Aa}	2.44±1.09^{Aa}	2.21±1.21^{Aa}	2.02±1.33^{Ab}	2.04±1.33^{Ab}	1.91±1.32^{Ab}	1.84±1.41^{Ab}	2.00±1.31^{Aa}
Tame	2.49±1.01^{Aa}	2.43±1.08^{Aa}	2.42±1.06^{Aa}	2.46±1.07^{Aa}	2.26±1.17^{Aa}	2.02±1.33^{Ab}	2.01±1.34^{Ab}	1.80±1.33^{Ab}	1.85±1.40^{Ab}	1.96±1.33^{Ab}
Understanding	2.13±1.29^{Aa}	2.02±1.33^{Aa}	1.99±1.33^{Aa}	2.11±1.30^{Aa}	1.82±1.39^{Aa}	1.99±1.38^{Aa}	1.98±1.36^{Aa}	1.83±1.35^{Aa}	1.81±1.40^{Ab}	1.96±1.34^{Aa}
Warm	2.65±0.84^{Ba}	2.67±0.82^{Ba}	2.51±0.97^{ABa}	2.58±0.93^{ABa}	2.30±1.13^{Aa}	2.13±1.29^{Ab}	2.21±1.24^{Ab}	2.00±1.27^{Ab}	1.99±1.34^{Ab}	2.00±1.27^{Ab}
Wild	0.95±1.37^{Aa}	0.91±1.37^{Aa}	0.99±1.39^{Aa}	1.05±1.41^{Aa}	0.97±1.37^{Aa}	0.76±1.24^{Aa}	0.81±1.28^{Aa}	0.81±1.25^{Aa}	0.75±1.22^{Ab}	0.71±1.21^{Aa}
Worried	0.11±0.54^{Aa}	0.05±0.35^{Aa}	0.09±0.44^{Aa}	0.11±0.52^{Aa}	0.16±0.63^{Aa}	0.10±0.53^{Aa}	0.06±0.38^{Aa}	0.18±0.63^{Aa}	0.13±0.55^{Aa}	0.13±0.58^{Aa}

Note: *For the emotional conceptualisation, a scale (RATA) was used that includes 0 = not present, 1 = low, 2 = medium and 3 = high. Values in upper case within rows with different superscripts are significantly different ($p \leq 0.05$) and compare the emotional conceptualisations between the different porridges of the same condition (control/informed). Values in lower case within rows with different superscripts are significantly different ($p \leq 0.05$) and compare the emotional conceptualisations of the same porridge between control and informed condition. [1]TM = termites without milk powder, [2]TM+M = termites & milk powder, [3]GH = grasshoppers without milk powder, [4]GH+M = grasshoppers & milk powder, and [5]M = no insects ("control").

FIGURES

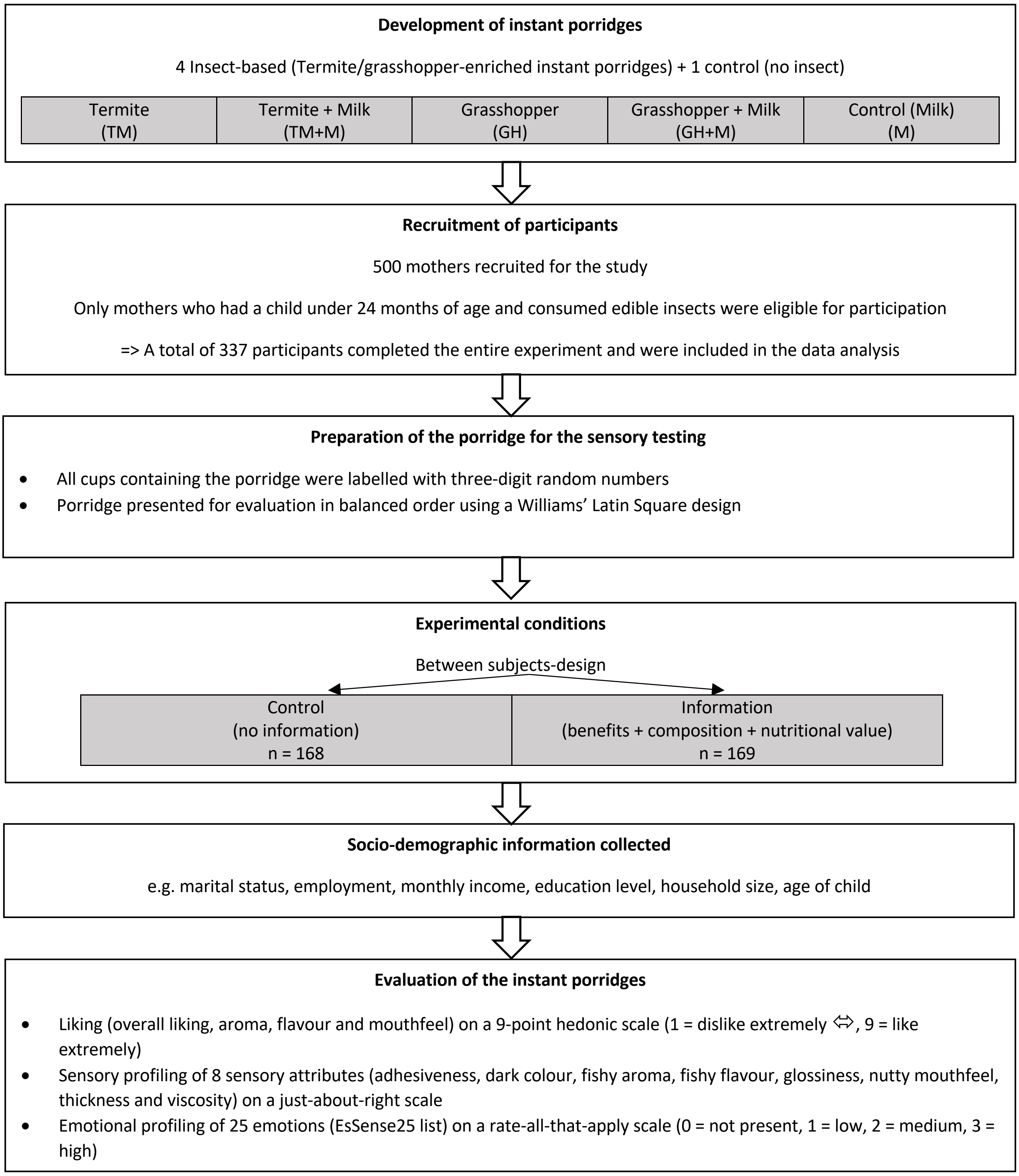
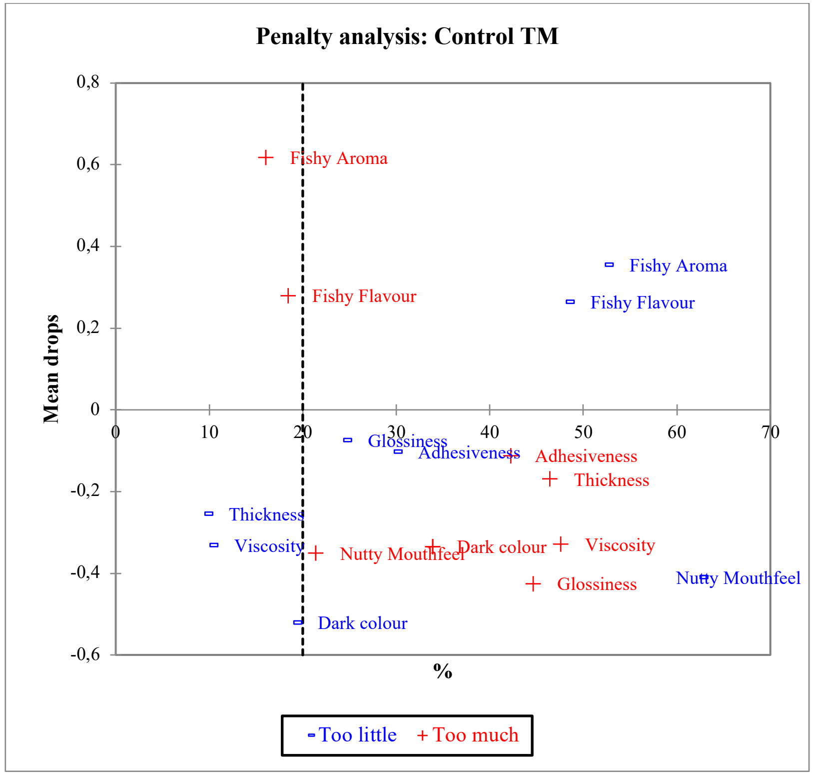
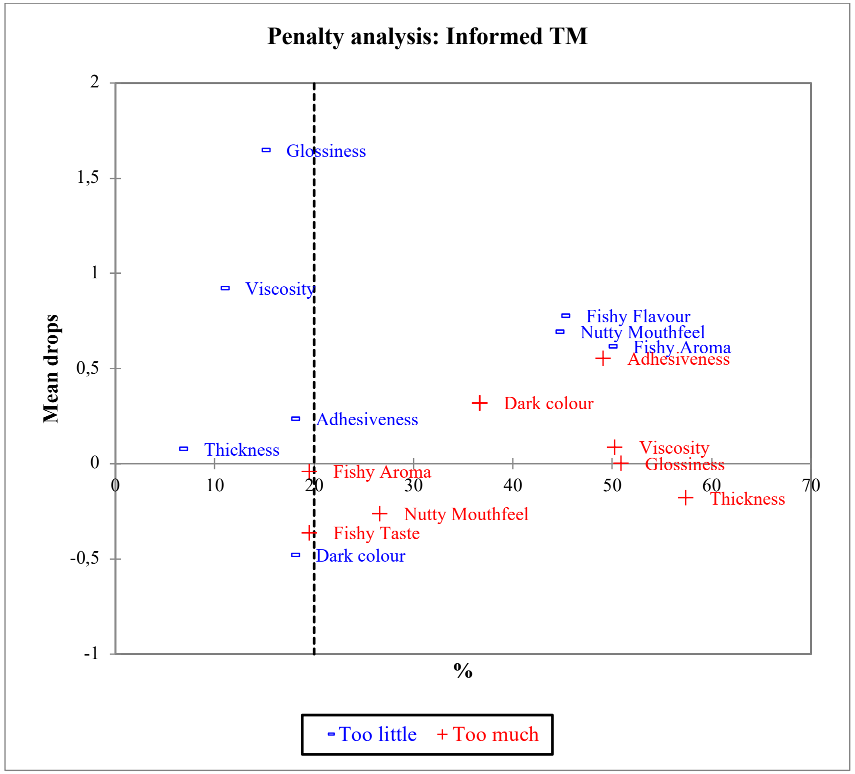
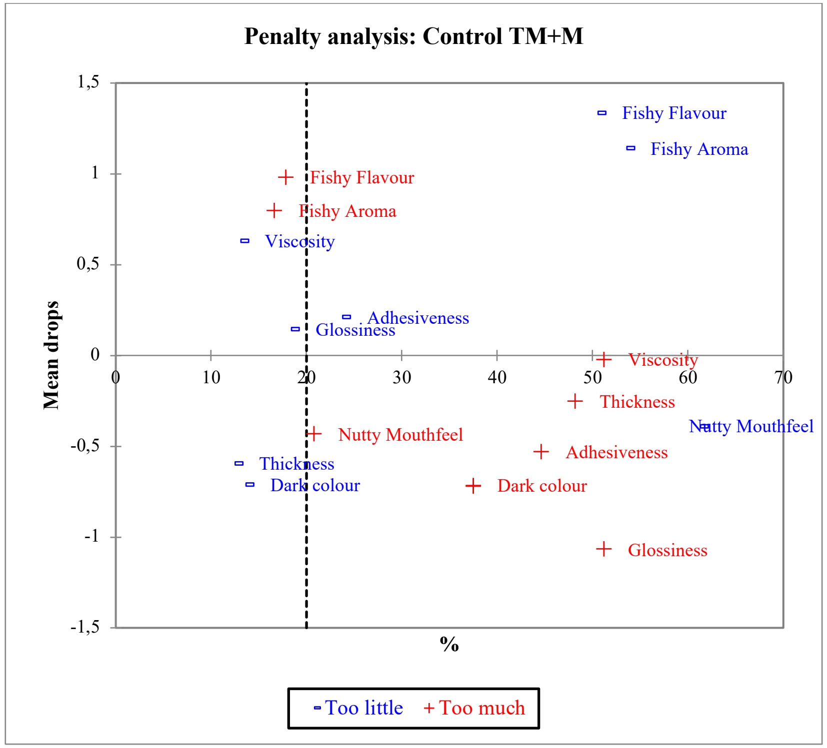


Figure 1: Experimental design and data collection


Penalty analysis: Control TM
Mean drops
%
Fishy Aroma
Fishy Flavour
Glossiness
Adhesiveness
Thickness
Viscosity
Nutty Mouthfeel
Dark colour
Too little
Too much


Penalty analysis: Informed TM
Mean drops
%
Glossiness
Viscosity
Fishy Flavour
Nutty Mouthfeel
Fishy Aroma
Adhesiveness
Dark colour
Thickness
Fishy Taste
Too little
Too much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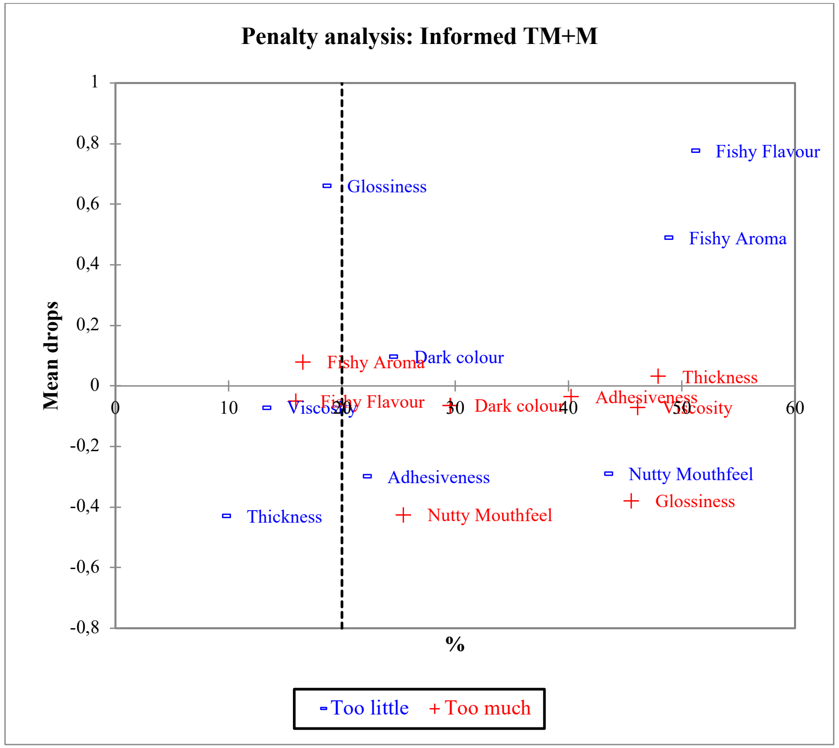
Mean drops
%
Fishy Flavour
Fishy Aroma
Fishy Flavour
Fishy Aroma
Viscosity
Adhesiveness
Glossiness
Viscosity
Thickness
Nutty Mouthfeel
Nutty Mouthfeel
Adhesiveness
Thickness
Dark colour
Dark colour
Glossiness
Too little
Too much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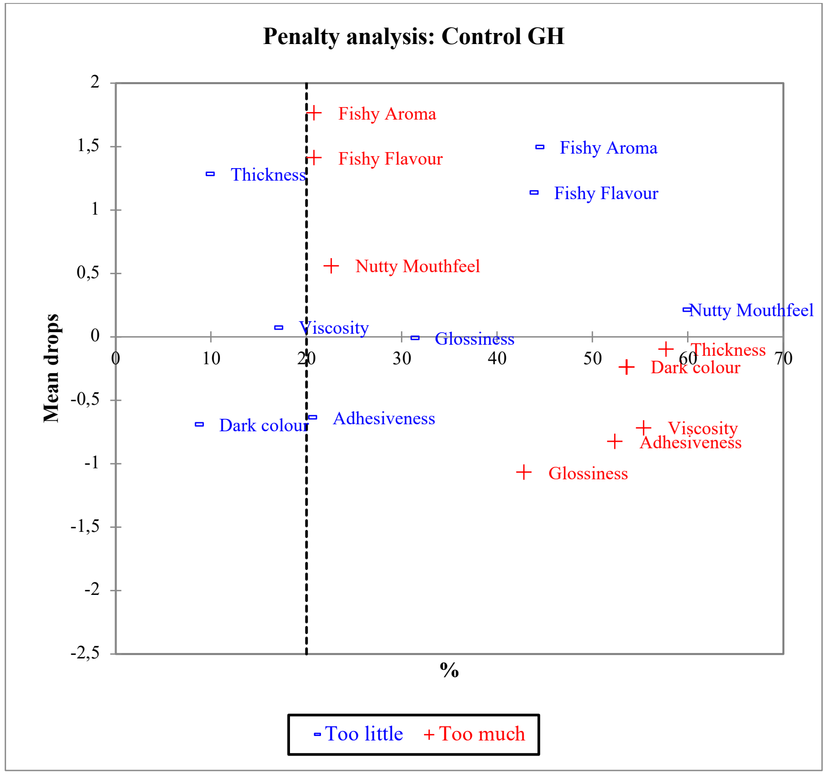
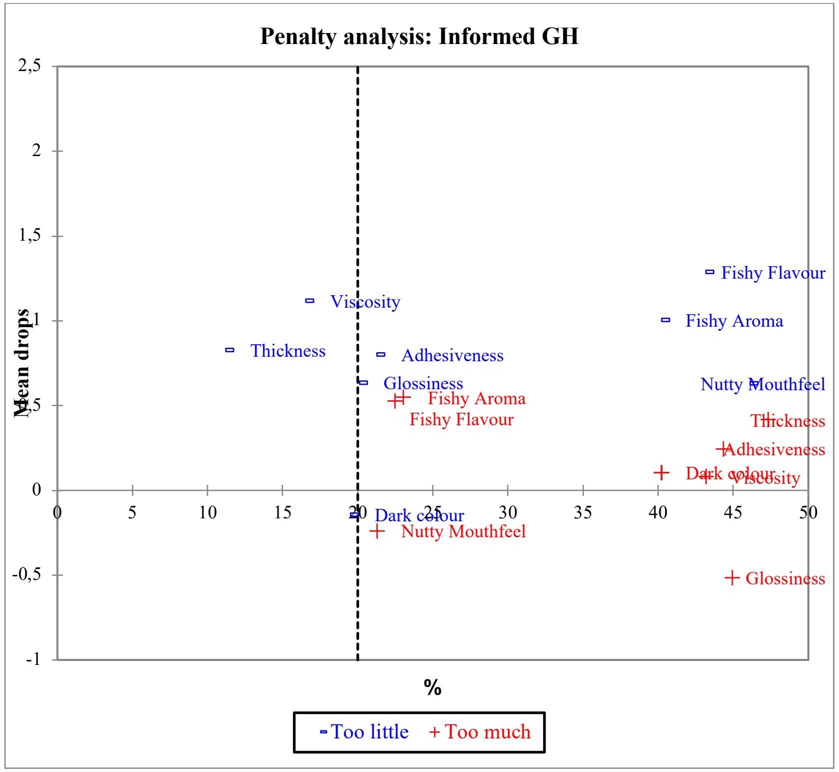
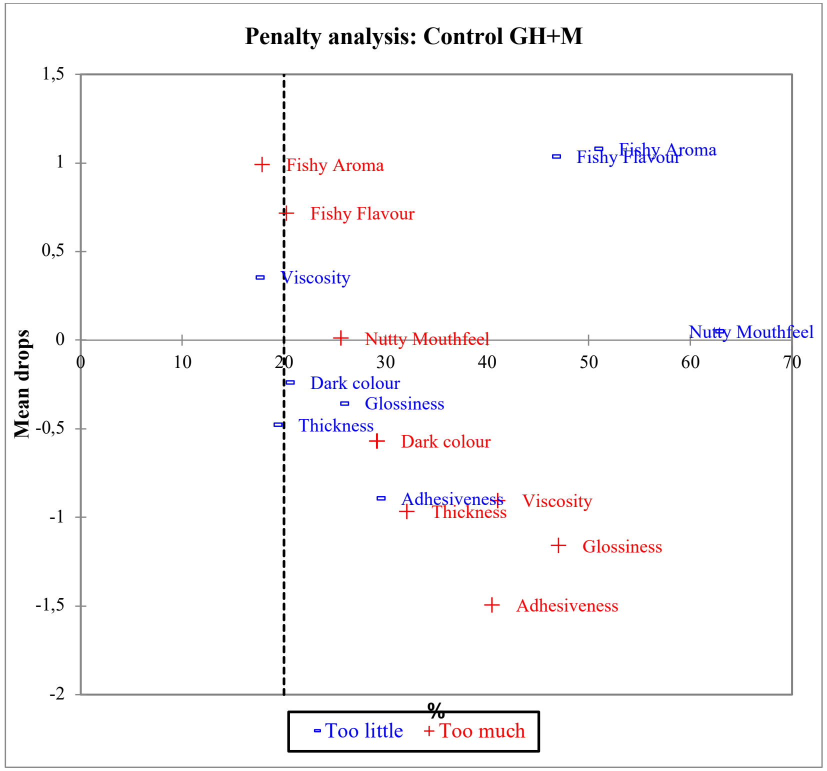
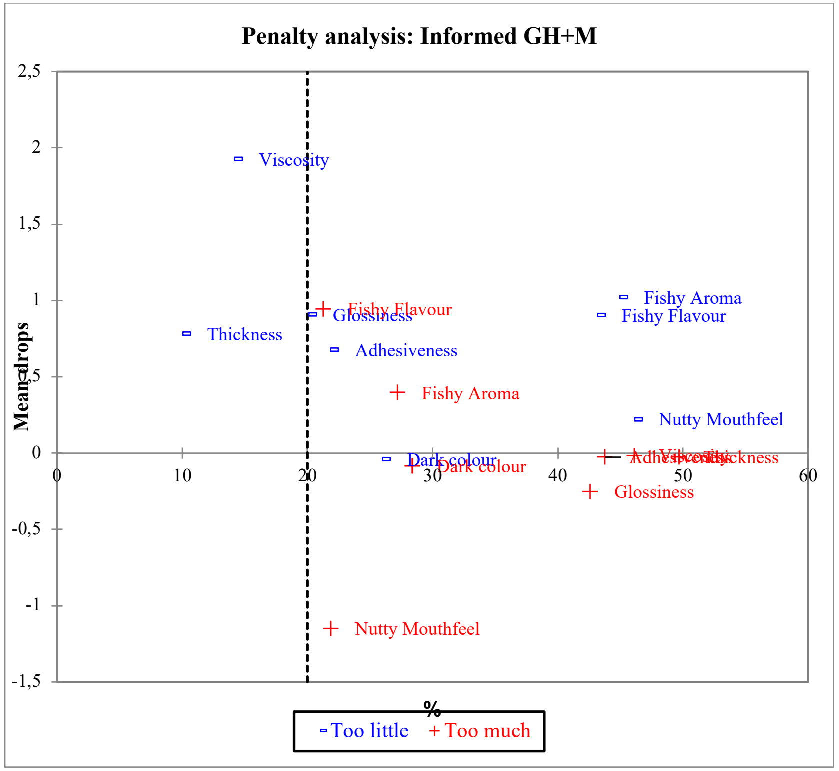
Mean drops
%
Fishy Flavour
Glossiness
Fishy Aroma
Fishy Aroma
Dark colour
Thickness
Viscosity
Fishy Flavour
Dark colour
Adhesiveness
Viscosity
Adhesiveness
Nutty Mouthfeel
Glossiness
Thickness
Nutty Mouthfeel
Too little
Too much


Penalty analysis: Control GH
Mean drops
%
Fishy Aroma
Fishy Flavour
Thickness
Fishy Aroma
Fishy Flavour
Nutty Mouthfeel
Nutty Mouthfeel
Viscosity
Glossiness
Thickness
Dark colour
Dark colour
Adhesiveness
Viscosity
Adhesiveness
Glossiness
Too little
Too much


Penalty analysis: Informed GH
Mean drops
%
Fishy Flavour
Viscosity
Fishy Aroma
Thickness
Adhesiveness
Glossiness
Nutty Mouthfeel
Fishy Aroma
Fishy Flavour
Thickness
Adhesiveness
Dark colour
Viscosity
Dark colour
Nutty Mouthfeel
Glossiness
Too little
Too much


Penalty analysis: Control GH+M
Mean drops
%
Fishy Aroma
Fishy Flavour
Viscosity
Nutty Mouthfeel
Dark colour
Glossiness
Thickness
Adhesiveness
Too little
Too much


Penalty analysis: Informed GH+M
Mean drops
%
Viscosity
Thickness
Fishy Flavour
Glossiness
Adhesiveness
Fishy Aroma
Nutty Mouthfeel
Dark colour
Too little
Too much

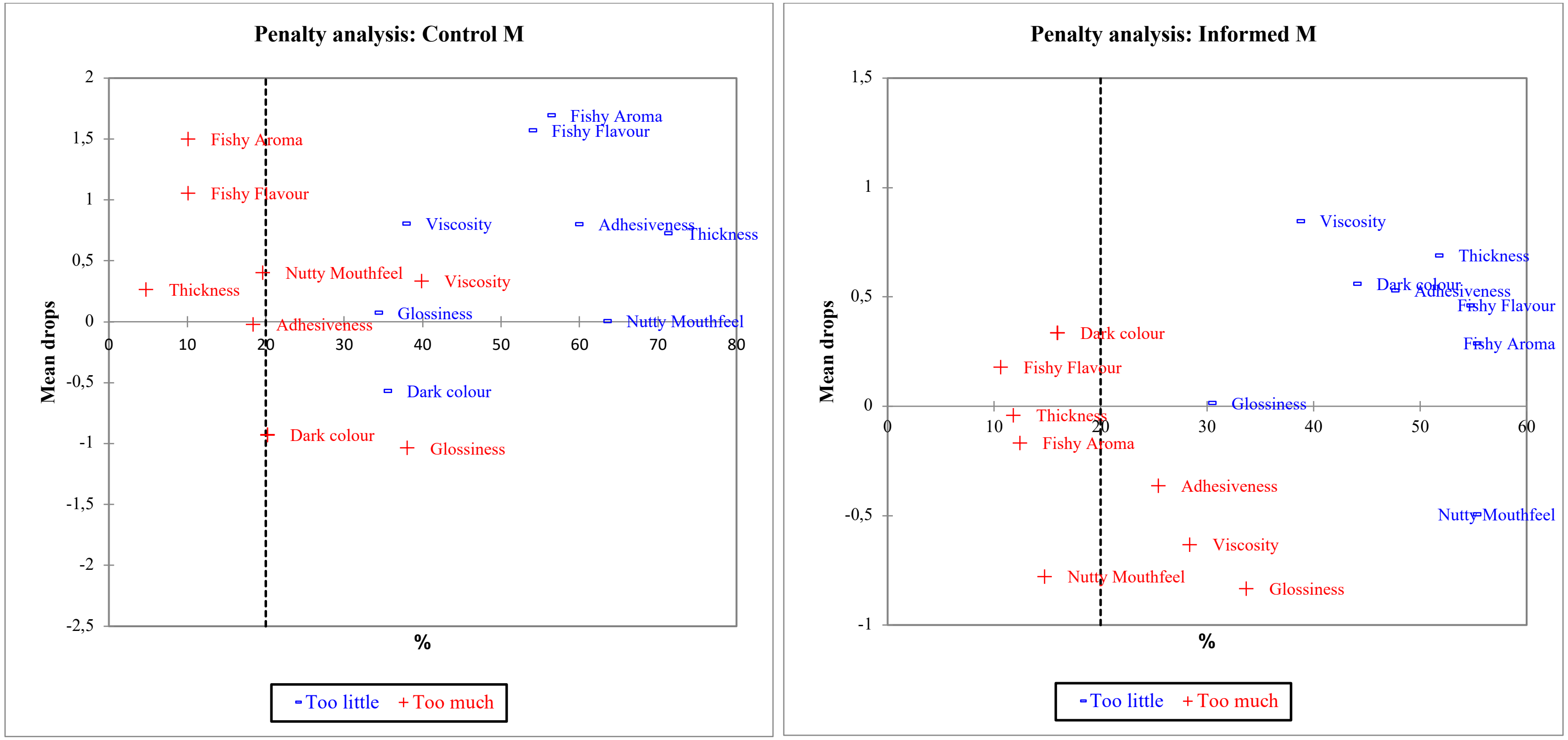


Figure 2: Penalty analysis for TM, TM+M, GH, GH+M, M samples under control (n=168) and informed (n=169) conditions.

TM = termites without milk powder, TM+M = termites & milk powder, GH = grasshoppers without milk powder, GH+M = grasshoppers & milk powder, and M = no insects ("control)