

## Article

# Insect-Based Foods: A Preliminary Qualitative Study Exploring Factors Affecting Acceptance and New Product Development Ideas through Focus Groups

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**Abstract:** While insect-based foods could contribute towards sustainable protein consumption and production, their successful adoption relies largely on consumer acceptance. This case study aims to explore factors affecting acceptance and to identify the insect-based foods that participants would like to be developed and introduced to the market. Three focus groups incorporating optional tasting sessions of insect-based foods were conducted in Ireland, a country where these foods were unavailable at the time of the study. Findings showed that before the tasting sessions, public opinion, portion size comparisons (insects vs. meat), and witnessing entomophagy-related disturbing experiences through television were some of the factors that negatively influenced acceptance. Lack of availability in Ireland was the main factor that hindered consumption among participants willing to consume these foods. Participants' usual food choice motives, sensory attributes, and inclusion percentages of insects in food were some factors which affected acceptance following the tasting sessions. A variety of insect-based foods was suggested for product development, which were mostly components of a main meal. The findings of this study could give an initial indication of product ideas that could be explored further for product development in regions where insect-based foods are not readily available on the market. These findings could contribute to future studies that would aim to build quantitative tools.

**Keywords:** entomophagy; alternative protein; sustainable consumption; product development; food choice



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## 1. Introduction

The increase in global consumer demand for animal protein due to the growing population and changes in consumption patterns continue soaring [1,2]. While more food sources in general are needed to maintain food security owing to the rising population, per capita animal protein intake is increasing significantly [1,3,4]. Consequently, the animal production sector has been expanding to accommodate these increasing consumer demands [1,2] despite the sector's long-standing association with a substantially high environmental footprint [5–10]. More alternatives are therefore needed that can potentially contribute towards both environmental sustainability and food security [11,12].

Among such alternatives are insects, which have been reported to have potential as a sustainable alternative to conventional meat due to their generally high protein content [13] and lower environmental footprint [14–16]. In addition, their potential contribution towards food security and a balanced varied diet is widely reported [17–21]. Insects have been part of the culinary culture for consumers in many parts of the world for centuries [13], while in the European Union (EU), for example, they were not “consumed to a significant degree before 15 May 1997” [22]. It was, however, only in the year 2021 that the production

and marketing of the first insect species (*Tenebrio molitor* larva/yellow mealworms) for human consumption was officially approved by the European Commission following risk assessment [23,24]. Since then, the *Locusta migratoria* (migratory locusts), *Acheta domesticus* (house crickets), and *Alphitobius diaperionus* larva (lesser mealworm) have also been approved [25–27].

Despite the advantages of consuming insects and the authorization from the European Commission, the successful adoption of insects as food relies on consumer acceptance, which, according to a recent review by Van Huis and Rumpold [28], is still low in Western countries. Over the last few decades, past studies have identified several factors affecting the acceptance of insects as food in these countries, including those in the EU region. Consumers' anticipated aversion towards insects or foods containing insects (insect-based foods) is one of the main factors found to affect acceptance, especially among consumers who have not consumed such foods before [29]. Other psychological factors, such as food neophobia and food disgust, have also been reported to reduce acceptance significantly [30–38], whilst food neophilia has been linked to an increased acceptance [36,39,40].

Tasting insect-based foods which closely resemble conventional food familiar to consumers has been shown to reduce the impact of psychological factors such as food neophobia and disgust significantly [29,41]. In general, willingness to consume insect-based foods in countries without an entomophagy culture depends on the extent to which insects are visible, with higher willingness reported when insects are completely invisible, and the lowest willingness reported when they are fully visible [30,38,42–46]. Nevertheless, Gmuier et al. [43] found that fully visible insects, such as whole insects, would be more preferred by consumers when presented alone than when mixed with conventional snacks. In addition, consuming insect-based foods where the insects are fully invisible can make consumers more willing to consume those products where the insects are visible [47] or generally help consumers become more accustomed to insects as food [48]. Indeed, previous experience with entomophagy has been linked with a greater acceptance of the practice [38,41,49–51].

While visible insects tend to receive lower acceptance from consumers, the acceptance level has been found to vary depending on the type of insect that is visible [52–55]. Reviewing past studies where this variation in consumer acceptance was observed, it seems evident that no umbrella conclusion applies to all consumers. For instance, consumer segments based on country of residence exhibit distinct differences. In Romania, consumers were found to be most accepting of ants and grasshoppers and least accepting of worms and cockroaches [55]. In contrast, consumers in the Netherlands were more willing to consume insects familiar to them through market availability, such as mealworms and grasshoppers, compared to cockroaches and moths, etc., which were not [52]. Similarly, in a preference ranking sensory test, Czech consumers ranked mealworms, discoid cockroaches, field crickets, and migratory locusts as their top preferences (in descending order) [54]. Italian consumers, on the other hand, demonstrated a greater willingness to consume insects in the adult stage of their life cycle, as opposed to those in the larval stages [53]. These studies were either conducted before the European Commission published the regulatory framework authorizing certain species and forms thereof as novel food in the EU or they included a mix of those included in this framework and those not included. A recent study found that providing consumers with information on this EU regulatory framework can significantly increase their willingness to consume insects [38].

Other factors, such as providing information on the environmental sustainability of insects as food [56], the sensory attributes of insect-based foods [57], personality traits [29], age [39,51,53,58–61], gender [41,62,63], and educational background [50], have also been reported to influence consumer acceptance of insect-based foods. However, just like the acceptance of the various insect species, the impact of these factors may vary from country to country [64]. For example, while some studies found young adult consumers in France [61], Greece [60], Belgium [58], and Italy [39] to be more accepting of insect-based foods, older consumers in Poland [63] and Spain [65] showed higher levels of acceptance. Differences can also exist between studies conducted in the same countries. For example, studies of

consumers in Finland by Vartiainen et al. [62] and Halonen et al. [51], or those among consumers in Germany by Hartmann et al. [30] and Orsi et al. [59], reported conflicting results on the effect of age on entomophagy acceptance. It is important to note, however, that entomophagy acceptance is a complex phenomenon affected by a combination of factors [66], and the differences in the effect of age, for example noted in these studies, could be influenced by the differences in the profiles of the participants investigated.

It is now a well-established fact that familiarity or increased exposure to insects as food through tasting sessions or product marketing, for example, could significantly increase consumer acceptance [28,29,36,41,52,61,67–69] to an extent where even visible or whole insects could become more acceptable [47]. This is important since consuming whole insects is reported to be a “better option” in terms of environmental sustainability compared to when they are disguised or invisibly incorporated into other foods [48]. Nevertheless, not all EU countries have the same exposure to insects as food. For example, more than a decade ago, it was reported that in the Netherlands, insects as food were already available for sale in some shops [13]. This might explain why Fischer and Steenbekkers, in their study over five years ago, found that consumers in the Netherlands preferred those insects that were already on the market [52]. A recent review found that the majority of insect-based food business operators in the EU are located in the Netherlands, Germany, Belgium, France, Finland, and Denmark, with their target consumers primarily residing in these countries [70]. However, this focus is now expanding towards consumers across the broader EU market [70]. To ensure the success of EU-wide trading, it is crucial to understand the differences in consumer acceptance of insect-based foods across various countries, particularly in regions where exposure to these products has been more limited compared to the aforementioned countries [38]. Moreover, when insect-based foods are also marketed in countries that do not have these on the market, it will give consumers in these countries an opportunity to become more familiar and accustomed to insects as food.

The current case study, therefore, focuses on participants residing in an EU country (Ireland) where insect-based foods have not been (and are currently still not) available in shops to date (based on our preliminary findings after a market screening (see the Section 2)) and which is among the top five meat producers in the EU [71]. Since the acceptance of the different EU-approved (whole) insect species may vary depending on consumers’ country of residence, the current study aims to answer the following research questions: (1) What are the factors affecting the acceptance of insect-based food products amongst participants in Ireland? (2) What are the insect-based food products that participants in Ireland would like to be developed or placed on the market?

While there have been a few studies conducted in Ireland investigating consumer acceptance towards entomophagy [38,50,66,72], this is the first study that attempts to provide preliminary insights on specific insect-based foods that consumers in Ireland may like to be developed or placed in the market. To help participants provide ideas for product development, they are given the opportunity to see and optionally taste various insect-based foods and ingredients. Therefore, instead of employing a quantitative approach, which relies on what is already known during its design (e.g., options provided in closed-ended questions), this study utilized a qualitative approach to allow participants to express their views freely without the constraints of past research [73]. Focus group discussions were chosen as the most suitable method for capturing rich, nuanced insights for this case study [74]. The findings from this study could inform the development of quantitative tools and the production of insect-based foods that are not only acceptable but desirable [75] to consumers without extensive exposure to insects as food.

## 2. Materials and Methods

### 2.1. Study Design and Sampling

To answer the research questions of this study, an interpretivist paradigm [76] and an embedded design was used, where a supplementary quantitative research component was embedded within the main qualitative research design [77] to achieve methodological trian-

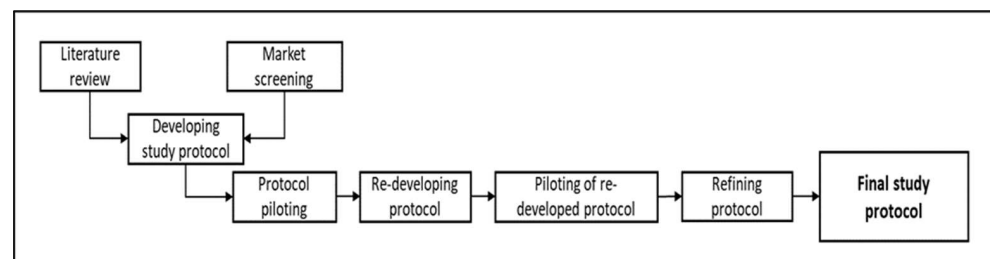
gulation [78,79]. Quantitative data collected using five-point scales on paper questionnaires during the focus groups were used to explain the qualitative findings. This study received ethical approval from the Institute Research Ethics Committee of the Atlantic Technological University (ATU), Sligo, in Ireland (Ref. No. 2022016).

Advertisement for this study took place via the ATU email network, word of mouth, researchers' social media platforms (Twitter, Facebook, LinkedIn), and physical posters placed in various educational establishments and local supermarkets. These different advertisement platforms were used to ensure wider customer reach, including customers with no access to social media. Those consumers who indicated an interest in participating in the focus group discussions upon reading the participant information sheet were screened. This screening was based on the exclusion criteria of this study, which were as follows: being a vegan or vegetarian, being under 18 years of age, being allergic to dust mites, and having any food allergies or medical conditions that may affect food intake. In addition, a maximum variation purposive sampling technique [80] was employed where consumers from all adult age groups, varying genders, as well as those willing and unwilling to taste any insect-based foods (by advertising the tasting sessions as "optional"), were recruited. Thereafter, only those who signed a consent form participated. In total, three focus groups were conducted, and each session lasted approximately 90 min. Each participant was given a 20 euros shopping voucher compensation for their time.

The final focus groups, which were conducted in the west of Ireland, consisted of an almost equal number of male (8/17) and female participants (9/17), and all the adult age groups (18–29, 30–39, 40–49, 50–59, 60, and above) were represented. Each focus group had between four to seven participants, and the distribution across the three focus groups depended on the availability of each participant. Participants were from diverse backgrounds, consisting of those who only had a secondary school education only and those with university education (social science and business, engineering, nutritional science, environmental science, and other fields).

## 2.2. Embedded Study Design Protocol

The principles of designing and conducting focus groups, as illustrated by Krueger and Casey [74], were followed in developing and executing the focus group protocol used in this study. This protocol was first piloted in June 2022 and again in September 2022 to two groups of five consumers in Ireland, respectively. It was then refined based on the findings, comments, and feedback from the participants of the two pilots [81]. Piloting focus groups have been reported to enhance the quality of the data to be collected significantly since the outcomes from the pilot can help to improve the clarity of the questions, the structure of the protocol, and the effectiveness of the moderators [82]. Figure 1 shows an overview of the different stages that were followed in the development of the protocol used in this study.



**Figure 1.** An overview of the different stages followed in developing the protocol of this study.

The final focus groups were divided into three sections. The first section began with the moderators introducing themselves, reiterating the purpose of the focus group and the expected duration, and stipulating ground rules for the sessions [74]. These rules were to facilitate the flow of the discussions, assure participants that there were no right or wrong answers, and to encourage them to feel free to express their views, even if they were

different from those of the group [74,83]. Therefore, all participants were asked to respect each other's opinions. Next, participants were asked to introduce themselves by answering three questions regarding their name, favorite food, and the reason for selecting that food. In the second section, participants were first asked if they had ever heard of the eating of insects or foods containing insects, i.e., insect-based foods, prior to this study. Those who were aware of the practice were then asked whether they had consumed these foods before and, if so, to share their experience with the group. Participants who had not consumed insect-based foods before, despite being aware of the practice, were requested to share the reasons that prompted them not to do so. This was followed by a discussion on all participants' willingness to consume and opinions regarding the practice.

The third section of the focus groups started with the optional tasting session. Each participant was presented with eight samples of insect-based foods for tasting that were chosen after a market screening, a glass of water, and scoring sheets. It had been found during the pilot stage that providing all the tasting samples to each participant would make them more comfortable to taste or not without drawing much attention to themselves, which could influence their willingness. In addition, participants were reminded that the tasting session was optional and that they did not have to taste all or any of the products they were unwilling to taste. Nevertheless, in that case, they were asked to write down the reasons for their unwillingness to taste any product on the scoring sheets provided. All or any of the samples provided could be tasted, though participants had to cleanse their palate with the provided water before tasting each product. Furthermore, for each product tasted, they were requested to score their overall liking on 5-point hedonic scales (from dislike very much to like very much) and willingness to buy (from very much unwilling to very much willing) on five-point scales using the scoring sheets provided and provide a reason for each score.

There were no discussions during the tasting session, so participants individually scored the insect-based food samples without discussing their opinions. This was done to allow them to provide their honest opinions of the products without external influence from others. Since this part of the focus group was not a discussion, to avoid indirectly and unwillingly exerting any pressure on participants towards tasting the insect-based foods provided, a refreshments station was provided, where participants could help themselves to snacks that were not insect-based should they not be tasting any of the insect-based samples. After the tasting session, those participants who had tasted any of the provided insect-based foods were asked to share with the group the one they liked most and the one they liked least, along with reasons for their selection. Participants who did not taste any samples were also asked to share the rationale behind their decision not to taste. Following this discussion, participants were presented with the insect-based foods provided during the tasting session in their original packaging and some available in other countries (cooking mixes, insect flour, gin, tapenade, burger patties, lollipops, chocolate slabs, and protein blend). A question was then asked if there were any other products, apart from the ones presented, that participants would like on the market/be developed with insects or components from insects. Finally, participants completed a pen and paper questionnaire wherein they were asked for information regarding their age, gender, highest level of education attained, educational background, and level of agreement to statements related to food neophobia and neophilia adopted from the Food Neophobia Scale [84]. The questions used in the protocol of this study are presented in Table S1.

### *2.3. Tasting Sample Selection and Preparation*

When this study was conducted, there were no insect-based foods available on the Irish market. Therefore, a market screening was conducted to identify insect-based foods easily accessible to consumers in Ireland via the online market. Figure S1 presents an illustrative screenshot sample from the market screening conducted in one of five EU countries where companies that could deliver insect-based foods to Ireland were identified. A total of eight products were selected and imported from EU-based companies for use



in the focus group optional tasting sessions of this study (see Figure 2). The selection of products was based on availability and level of insect visibility [43], that is, products where the insects are in their usual form (i.e., whole insects), products with small insect fragments, and products with no insects visible. Whole insects were selected based on the insect species that were approved for human consumption in the EU at the time the study was conducted, i.e., yellow mealworms [23,24], migratory locusts [25], and house crickets [26]. The dried and seasoned versions of these insect species were included to evaluate if there are differences in consumer acceptance across these species and that of other products. In addition, those food products that included only these EU-approved insects as ingredients were considered, and participants were informed of this before the tasting sessions. As can be seen in Figure 2, two products with different-sized insect fragments were chosen (crackers and chips), and there were three products where the insects were not visible (pasta, spread, and protein bar). All these insect-based products that were presented to the participants during the optional tasting session were handled and prepared under hygienic conditions in a food-grade environment. Only the insect-based pasta had to be cooked before the sessions, while the rest were ready-to-eat products.



**Figure 2.** Insect-based products that were presented to the participants during the optional tasting session.

#### 2.4. Data Analysis

The qualitative data obtained were analyzed via following the six phases of thematic analysis, as delineated by Braun and Clark [85,86]. These phases are, “data familiarisation and writing familiarisation notes” (phase 1), “systematic data coding” (phase 2), “generating initial themes from coded and collated data” (phase 3), “developing and reviewing themes” (phase 4), “refining, defining, and naming themes” (phase 5) and “writing the report” (phase 6) [86]. Although Otter.ai software (version 3.30.0-90c819b7, US, available online <https://otter.ai>, accessed on 25 January 2023) was used to transcribe the focus group recordings verbatim, the first author familiarized themselves with the data by listening to all the audio recordings while going through the corresponding transcripts. The transcripts were read several times while highlighting key points and making notes (phase 1). Thereafter, data were coded according to each question of the focus group from which initial themes were generated (phases 2 and 3). These themes and codes were revised and refined during the fourth and fifth phases, where they were aggregated and aligned to the study’s research questions. For each stage of thematic analysis, reflexive notes were added where the first author explained the rationale behind the naming of the codes and themes. The

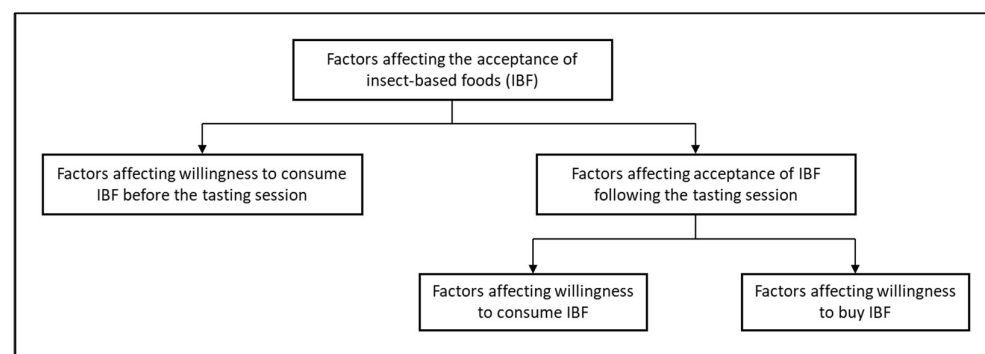
thematic analyses were conducted in such a way as to create an audit trail of the processes followed during each stage of analysis. This audit trail was then reviewed by the remaining two authors of this study to ensure validity. The findings are presented according to their themes along with the associated participant quotes. Participant number, gender, and age range are used to label each quote.

Descriptive statistics (frequencies) were used to analyze the quantitative data on participants' overall liking and willingness-to-buy scores, as seen in the Supplementary Material (Tables S2 and S3). In the current study, which has a qualitative focus, the quantitative data are used to explain and discuss the qualitative data obtained. No inferential statistics were conducted due to the small sample size.

### 3. Results and Discussion

#### 3.1. Factors Affecting Acceptance of Insect-Based Foods

Thematic analysis based on the first research question, “What are the factors affecting the acceptance of insect-based foods amongst participants in Ireland?” generated two overarching themes. These themes were “factors affecting willingness to consume insect-based foods before the tasting session” and “factors affecting acceptance of insect-based foods following the tasting session”. The latter was divided into two, that is, “factors affecting willingness to consume insect-based foods” and “factors affecting willingness to buy insect-based foods” (see Figure 3).



**Figure 3.** Themes associated with the research question, “What are the factors affecting the acceptance of insect-based foods amongst participants in Ireland?”.

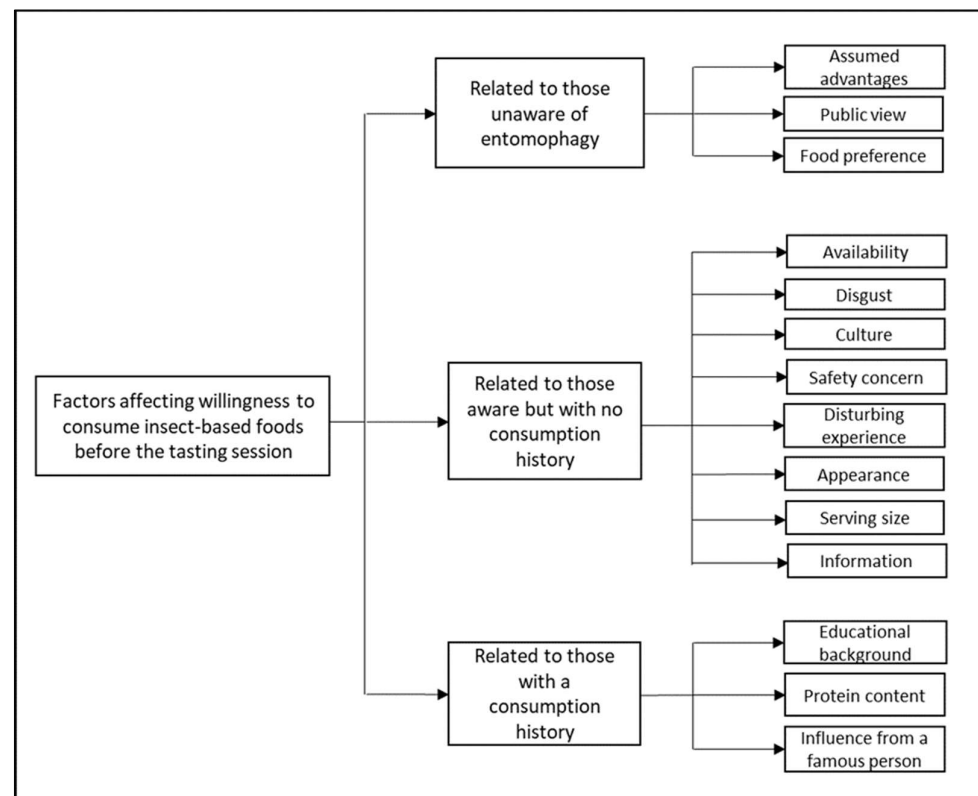
##### 3.1.1. Factors Affecting Willingness to Consume Insect-Based Foods before the Tasting Session

The theme “factors affecting willingness to consume insect-based foods before the tasting session” was divided into three subthemes, i.e., factors related to those participants who had never heard of entomophagy before (those unaware of entomophagy), factors related to participants who had heard of entomophagy but had not consumed any insect-based foods before (those aware of entomophagy but with no consumption history), and factors related to the participants who had heard of entomophagy and had proceeded to consume insect-based foods before this study (those with a consumption history), as shown in Figure 4.

Assumed advantages of consuming insects, public view, and personal food preference were the three factors found to affect willingness to consume insect-based foods amongst participants who had never heard of entomophagy. Upon hearing of entomophagy for the first time, some assumed that insect-based foods would be beneficial to health, leading to an openness in consuming these foods and even considering them to be on par with conventional foods (e.g., “I kind of see it the same way everybody eats meats and different sort of animal products. I am not sure why we don’t already eat it if it’s a healthy way of doing it.” (P8/Female/18–29)), though there was hesitation due to the negative public view on insects as “creepy crawlies”. A preference for conventional foods was the main barrier to acceptance

(e.g., “That’s a new idea. But I think I prefer because I am a sensitive person. I am a sensitive person about foods, so I prefer like meats. And not these new foods.” (P11/Female/30–39)).

The differences in willingness to consume insect-based foods among participants who were unaware of entomophagy could be attributed to food neophobia. For example, participants who expressed an unwillingness to consume insects also “strongly” agreed to the statement of not trying foods they are unfamiliar with, explaining their preference for conventional foods, while the others “strongly” disagreed to this statement. Similarly, previous studies found food neophobia [30,32,35–37,50], negative views of peers regarding entomophagy, and preference for familiar foods to significantly reduce the acceptance of insect-based foods among consumers [72].



**Figure 4.** A schematic summary of the subthemes and factors associated with the theme “factors affecting willingness to consume insect-based foods before the tasting session”.

Table 1 shows the factors and corresponding quote examples associated with the subtheme “factors related to those aware of entomophagy but with no consumption history” (see Figure 4). Participants willing to consume insect-based foods named the lack of availability of these foods in Ireland as a reason for not having consumed them before. This agrees with the findings from the market screening phase of the protocol development of this study, where no insect-based foods were found in Ireland and therefore had to be imported for the focus group tasting sessions. Low availability had been named in previous studies conducted in the EU as being one of the main barriers to insect-based food consumption among participants who might otherwise consider trying it [87,88]. However, some participants in the current study were concerned about the safety of insect-based foods, mirroring findings from Cicatiello et al. [89]. The concern among these participants in the current study led to questions regarding the sufficiency of the amount of research that has been conducted to verify the safety of insects for human consumption. Consequently, these participants requested more information regarding the safety aspect and strategies for alternating conventional foods with insects before being certain of their willingness to consume insect-based foods (see Table 1).



**Table 1.** Factors and corresponding quote examples associated with the subtheme “Factors related to those aware of entomophagy but with no consumption history”.

Factors	Quote Example
Availability	<i>“It’s the type of thing you hear about people trying you know, on street venues in Thailand when they go on holidays. It’s not really something you find here.”</i> (P3/Female/40–49)
Disgust	<i>“Because eating insects is kind of disgusting. If you think about eating a worm, or something like that, I prefer to eat beef instead of that.”</i> (P9/Male/30–39)
Culture	<i>“I think culturally I’ve never seen them as a source of food.”</i> (P13/Male/50–59)
Safety concern	<i>“But then I think about what’s inside an insect and have we done enough research to be able to know that it’s not going to hurt us and it’s going to be good for us in the long term. . .”</i> (P3/Female/40–49)
Disturbing experience	<i>“My first ever experience of seeing somebody eating insects, was, I arrived in China one evening, and there was an island in the middle of the road. And I saw a man with his bare hands just digging through the side and taking all the insects and eating them alive. And there was quite a shock to my system. It never went out of my mind and anytime I ever saw them say through a vendor, I’d always have a reaction against them.”</i> (P12/Male/60 and above)
Information	<i>“. . . And I think I’ve heard that they contain a high level of protein. And I’m not sure about that. I would like to know more. if there has been enough research about having them and alternating them for meat and other type of food.”</i> (P1/Female/18–29)
Appearance	<i>“I think like you see a picture of your lamb or your cow or your whatever else, it’s quite a friendly looking thing. Insects are not friendly looking. If you just put that in a box but when you look at the box and that’s what’s in the packet, whatever, you know, you don’t want to be eating that kind of thing.”</i> (P6/Male/40–49)
Serving size	<i>“I would give them a go anyway but if I was to consume them from a protein source, I just figured that I’d have to eat a huge amount to them, instead of a piece of steak. And I don’t know, could I bring myself to eat that volume to get the same level of protein as I would from my piece of fish or chicken or meat.”</i> (P16/Female/50–59)

A culture which does not include entomophagy, the appearance of insects, disgust, and a disturbing experience were other factors which led to some participants being unwilling to consume insect-based foods despite having heard of entomophagy before. While culture [90], product appearance [89], and disgust [29] have been factors known to affect entomophagy acceptance based on previous research, the current study also shows that witnessing a disturbing experience related to entomophagy could lead to rejection. The sources of disturbing experiences reported in this study were person-to-person experiences outside Ireland and television programs, which were also sources of entomophagy knowledge among some participants.

Protein serving size comparisons between insects and conventional meat led to doubts regarding the consumption of insects in this study. There was an assumption that one would need to consume an intolerably large portion of insects in order to obtain the same level of protein from a much smaller portion of conventional meat. According to a protein content comparison conducted between a 100 g portion of some of the EU-approved insects (house crickets, yellow mealworms) and a 100 g portion of conventional meat (beef, mutton, chicken, etc.), the protein content of these insects was generally comparable to that of conventional meat for the same weight [91]. It might be that since insects are relatively smaller in size, a 100 g portion might seem overwhelming to some consumers compared to a 100 g portion of meat, which could possibly be solved when incorporating insect-derived ingredients such as insect protein into conventional foods.

Those participants who had heard of entomophagy and proceeded to consume insect-based foods prior to the focus groups reported to have been influenced by three factors, namely, educational background, protein content of insects, and a cooking demonstration from a famous person such as a Michelin star chef. For example:

*“I don’t know if I’d actually just go down to a local shop and buy a pack of ants but when I was having a Michelin star chef demonstration with it, you can be a little bit more open with the experience. And it was fine. I guess, you kind of like say why not?”*  
(P14/Male/60 and above)

An Irish study also found educational background and nutritional value to influence willingness to consume insects [50]. However, Cavallo and Materia [92] found a high-protein content claim on insect-based foods to decrease Italian young adults’ acceptance of these foods significantly. In the current study, those participants who were positively influenced by the protein content of insects were older (over 50 years of age) compared to the young adult (18–35 years old) participants in the study by Cavallo and Materia [92], which could explain the differences in findings. All the participants in the current study who had consumed insect-based foods before were men aged 50 years and above. Likewise, older consumers and men in general have been reported as being more willing to consume insect-based foods [62]. Nevertheless, in the current study, some younger participants were also willing to consume insect-based foods but had no opportunity to do so due to a lack of availability of these foods in Ireland (see Table 2). This might be why all the participants who had consumed insect-based foods prior to this study were among those who had heard about entomophagy through international travel (outside of Ireland). However, some were only willing to consume insects after seeing a demonstration on insect preparation by a Michelin star chef. Similarly, insect-based chef demonstrations have been found in previous studies to have an influence on Italian, French, and British consumers [93,94].

### 3.1.2. Factors Affecting Acceptance of Insect-Based Foods Following the Tasting Willingness to Consume Insect-Based Foods

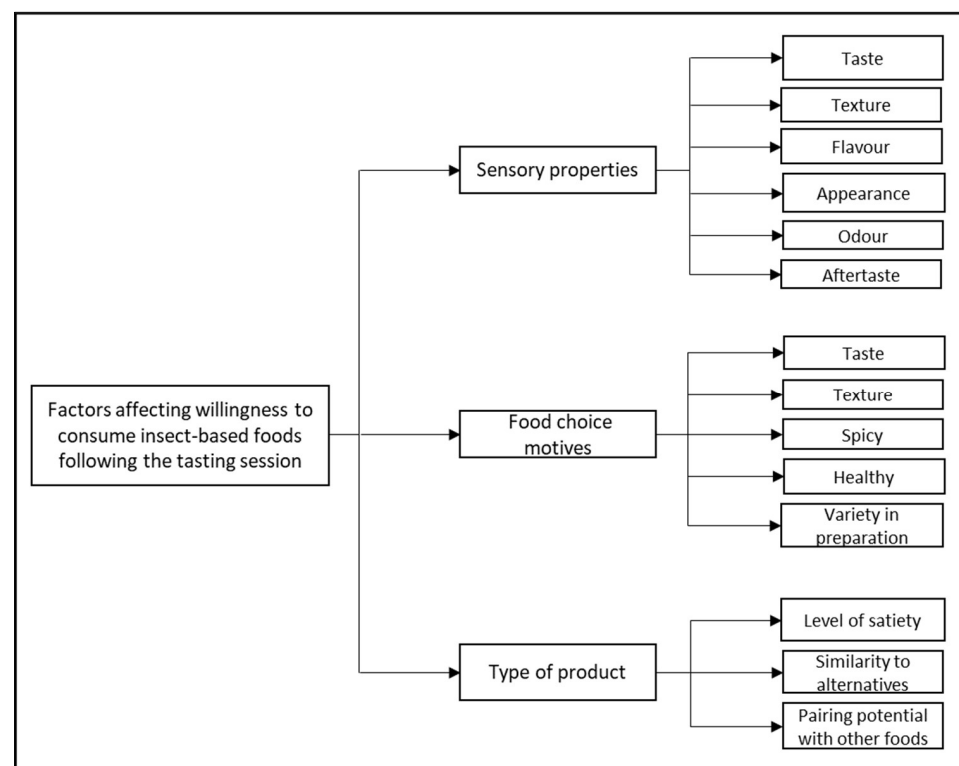
Before the tasting session, some participants had expressed unwillingness to consume insect-based foods, citing several reasons such as food preference, disgust, culture, disturbing experience, etc. (see Figure 4). However, when the participants were given the opportunity to taste the insect-based foods provided during the tasting sessions, all of them tasted the insect-based pasta, crackers, chips, spread, and protein bar. These were products where insects were either completely invisible or partially visible in small fragments (see Figure 2). Similarly, findings of earlier studies found consumers generally to be more willing to consume insects when disguised in a familiar product [43,50,95,96].

Several studies [29,41,97] found that willingness to consume insect-based foods significantly increases when participants are provided with some samples for tasting, which might have been the case in the current study. The inclusion of a tasting session in the study design could be viewed as an indirect intervention which might have possibly encouraged participants to taste the insect-based foods provided. Moreover, just before the tasting sessions commenced, participants were informed that three insect species had been approved (at the time the study was conducted) for human consumption in the EU after a risk assessment and that the insect-based foods presented before them contained only the approved insects. This information was provided to the participants as some had expressed safety concerns.

Nonetheless, not all participants in this study tasted the whole insects, i.e., yellow mealworms, migratory locusts, and house crickets. Comparably, several studies concluded that consumers generally prefer insect-based foods that do not retain the shape/form of insects to those that do [36,53,64]. Although findings from several studies [38,50,95,96] point to a greater consumer acceptance of products where the insects are not visible, when participants in the current study were asked to share with the group the insect-based product they most liked, all the products (including whole insects) were named apart from the pasta, while the pasta and crackers were among the least liked.

Willingness to consume the three EU-approved insect species (yellow mealworms, migratory locusts, and house crickets) in this study differed among species. More participants tasted the house crickets, followed by the yellow mealworms and, lastly, the migratory locusts (see Table S2). Findings from a previous study revealed that consumers mostly prefer insects at the adult stage of the metamorphic lifecycle, such as grasshoppers and crickets, for example [53]. In the current study, yellow mealworms were more liked than migratory locusts (see Table S2), similar to what was found among Czech consumers [54]. Nevertheless, a literature review of some published studies in EU countries (Italy, Czech Republic, Romania, and the Netherlands) revealed differences in consumer acceptance across insect species, with preferences varying for each country [52–55]. These differences in acceptance of insect species across countries justify the differences found in the current study, which is the first one undertaken in Ireland to explore the acceptance of the EU-approved insect species.

The theme “Factors affecting willingness to consume insect-based foods following the tasting session” consisted of three sub-themes viz. factors related to the sensory properties of the insect-based food, factors related to the participants’ usual food choice motives, and factors related to the type of insect-based product provided (see Figure 5).



**Figure 5.** Subthemes from the theme “factors affecting willingness to consume insect-based foods following the tasting session”.

Sensory factors such as taste, texture, flavor, appearance, odor, and aftertaste influenced participants’ overall liking of the insect-based foods. In terms of appearance, participants mainly considered the shape/form, insect visibility (fully disguised, partially disguised, or not disguised), and presence of seasoning. Appearance was also the sensory property, and the only factor, that caused some participants not to taste the migratory locusts, yellow mealworms, and house crickets. Although in several past studies, taste was found to be a determining factor of acceptance of insect-based foods [38,66,72,87], the current study shows that in the case of whole insects, appearance could be more important:

*"I did not taste the Locusts and Mealworms. it looks like it's not processed just dried so. but I tried this insect (house crickets) because I could see that there was some seasoning going on." (P7/Female/18–29)*

*"I didn't taste the locust so that would be my least favourite. I actually picked it up, the locust and I actually saw the eyes looking back at me. look, I'm going out for dinner now and I can't eat now because you know." (P13/Male/50–59)*

The effect of the above sensory properties on the overall liking of the insect-based foods provided depended on participants' personal preferences. For example, while some would prefer a product for its taste, others would not prefer the same product due to a dislike of its taste, as was also found by House [87]. These differences in the current study regarding participants' preferences could explain the variances found amongst participants' most or least liked insect-based products during the discussions.

At the start of the focus group discussions, participants were asked to name their favorite food and provide the motives for their product choice. Similarities were found between some participants' food choice motives (taste, texture, spicy, healthy, and variety in preparation) and the factors considered when evaluating the insect-based foods provided (see Table 2).

**Table 2.** Example quote comparisons between participants' food choice motives and evaluation of insect-based foods.

Food Choice Motive	Quote Example (Food Choice Motive)	Quote Example (Relating to the Insect-Based Food)
Texture	<i>"...because of the variety of spices and you can have different textures." (P4/Female/30–39)</i>	<i>"I liked the seasoning. The texture could be more crunchy and less dense-closer to a tortilla chip." (P4/Female/30–39)</i>
Variety in preparation	<i>"...I like the variety that I can add to pasta in that I can have it with chicken or fish, or I can have a bit with vegetarian I can change the sauces. So yeah, I like pasta and the dishes, or sauces." (P16/Female/50–59)</i>	<i>"The texture of the pasta is good. Flavour is bland but I would add with sauce." (P16/Female/50–59)</i>
Healthy	<i>"...because they're healthy, and they're good for me". (P3/Female/40–49)</i>	<i>"I could imagine myself having you know the cracker instead of like an oak cake. I thought they're just really an easy snack, they're mild they're not too salty. The chips, they don't taste really oily yeah, I enjoyed them". (P3/Female/40–49)</i>
Spicy	<i>"...because it has spice in it. And I love spices as well." (P7/Female/18–29)</i>	<i>"I did not taste the Locusts and Mealworms. it looks like it's not processed just dried so. but I tried this insect (house crickets) because I could see that there was some seasoning going on." (P7/Female/18–29)</i>
Taste	<i>"...the taste of that food is the main reason that I really like it." (F9/Male/30–39)</i>	<i>"I didn't like the locust. The taste is not good". (F9/Male/30–39)</i>

Concerning the factors related to the type of insect-based foods provided, participants preferred those that could easily be paired with other conventional foods (crackers, pasta, and house crickets) and provided a feeling of satiety (protein bar). Participants also preferred the products that resembled the alternatives or foods they usually like. However, when insect-based foods resembled alternatives that participants typically do not consume, it negatively impacted their overall liking of these products.

### Willingness to Buy Insect-Based Foods

The theme “factors affecting willingness to buy insect-based foods following the tasting session” yielded six subthemes. These were factors related to the sensory properties of the food, price, promotion/marketing strategy, knowledge, type of product, and nutritional content. Participants’ liking or dislike of the sensory properties of the provided insect-based foods, such as their taste, texture, flavor, appearance, and aftertaste, influenced their willingness to buy them (e.g., *“Perhaps if it had more flavour and not as crunchy, I would purchase”* (P10/Female/18–29)).

Participants scored their willingness to buy for each product they tasted (see Table S3), giving reasons for each score. Based on these data, it emerged that participants were more willing to buy the insect-based foods they sampled if the price was lower or competitive with alternatives, if they were promoted/marketed as sustainable, if they could be paired with other foods, if they were filling, or for their generally high protein content. In addition, when the insect-based foods resembled an alternative product that participants typically bought, this had a positive effect on their willingness to buy. Conversely, resemblance to products they rarely bought had a negative effect (e.g., *“Looks like whole meal pasta, something I usually don’t purchase”* (P15/Male/50–59)).

Not knowing how to prepare insects in their usual form at home or the ingredient lists of the insect-containing foods had a negative impact on the willingness to buy scores for these foods amongst some participants. When participants were shown the product packaging and the ingredient list of the provided foods, some thought the percentage of insects in some of the products (i.e., 5%, 10%, and 12%) was very low or “just a token gesture” to be considered insect-based. In another study, participants preferred insect-based foods with lower insect inclusion rates instead [88]. In the current study, those participants who would have preferred higher insect inclusion rates had expressed an interest in consuming insects as a protein source in protein-fortified foods (such as insect-based pasta or protein bars), which might have not been the case in the other study.

### 3.2. Insect-Based Food Product Development Ideas Suggested by Participants

Table 3 presents the insect-based product ideas that participants came up with when asked to think of other products that they would like to be developed or placed on the market (not including the products provided to them at the tasting session). Participants’ ideas ranged from insect-based sauces/paste, snacks, cereals, herbs/spice mixes, and pasta to products with texturized insects. This range of products was strikingly different to a previous study conducted in Ireland, wherein participants mainly preferred insect-based foods in the form of snacks [72]. In the current study, out of the 13 insect-based foods suggested by participants, only two (chips/crisps and “insect-gherkin”) were snacks. This difference could be explained by the fact that the previous study conducted in Ireland [72] did not include a tasting session, and nor did it physically present a range of insect-based foods to participants, as was done in the current study, which might have led to anticipated aversion [29] amongst participants. In the current study, most of the products suggested by participants (10/13) were components of a main meal, which agrees with what was found by Brynning et al. [98], where Danish consumers preferred insect-based foods as part of a main meal instead of a snack.

In the current study, in some cases, when a participant would share an insect-based product idea during the discussions, other participants would agree and then contribute to its conceptualization, highlighting the advantage of using focus groups. Most of the products suggested involved disguising insects completely so that their form is not retained. Moreover, some participants suggested ideas that were strikingly similar to their food choice motives. For example:

Food choice motive—*“I like Mexican food because of the variety of spices, and you can have vegetables in it, or you can have different textures.”* (P4/Female/30–39).

Insect-based food product idea—*“By finding some of the flavours and the texture of the bugs and insects quite nice, could it be like a herb mix that you toss vegetables in and roast them*



*or something that you get the texture, and you'll get the protein, and you will get the spices but wouldn't see the bodies of the insects. . ."* (P4/Female/30–39).

**Table 3.** Insect-based food product development ideas suggested by participants.

Product Name	Product Description	Availability <sup>1</sup>
Protein powder	Powder made with insect protein for use in soups or broths.	x
Curry paste	Ground insects or insect protein incorporated into a curry paste.	x
Dumplings	The dough for dumplings made with a combination of insect flour and glutinous flour. Alternatively, the filling could be made using insects instead of meat where the insect-mixture will have a burger patty texture.	x
Chips/Crisps	Chips/crisps made using insect flour.	ü
Insect-gherkin	Insects made to resemble gherkins.	x
Pasta	Modifying the insect-based pasta that was provided during the tasting session by using a mixture of insect flour and semolina flour instead of the lentil flour, which was used together with the insect flour in the pasta provided.	x
Pasta sauce	Incorporating ground insects or insect protein into a pasta sauce.	x
Pulled insects	An insect version of pulled pork or pulled oats: having the insects processed so that they resemble the texture of pulled pork for example.	x
Breakfast cereal	Incorporating insects into breakfast cereals such as granola. Alternatively processing the insects so that they resemble cheerios' branded cereals in shape.	x
Spice mix	Developing a spice mix using ground insects which can be used as a spice.	x
Herb mix	Developing a herb mix using slightly ground insects which can be tossed on vegetables when roasting them, can be tossed on salads, or can be used as a topping on pizza, for added texture, protein, and spice. The topping could also include nuts and seeds.	x
Formula sauce	Developing a sauce that includes insects and basil.	x
Ice cream sauce	Incorporating ground insects into an ice cream sauce.	x

<sup>1</sup> Based on the online market screening conducted at the time of this study (no insect-based foods were available in Ireland); x = not available; ü = available (only if it includes the EU-approved insect species).

### 3.3. Limitations and Strengths

One of the main limitations in studies that include tasting sessions is that people already interested in trying the provided foods volunteer to participate [66]. Nevertheless, the current study aimed to overcome this limitation by making the tasting sessions optional and highlighting this during the participant recruitment stage. Indeed, some people did not taste all the insect-based foods offered to them. Qualitative studies are not meant to be generalizable [99]. However, the qualitative analysis used in this study can provide useful insights that quantitative studies cannot, and the present study revealed important insights in relation to themes and insect-containing foods that could be explored further by the food industry. Each focus group had between four and seven participants, which meant fewer

collective findings compared to larger focus groups [74]. However, smaller focus groups have an advantage in that they enable effective interaction, allowing ample opportunity for each participant to express themselves fully, something not otherwise possible in large focus groups or in a mainly quantitative study [74]. Smaller sample sizes in general are not uncommon in qualitative inquiry where the aim is to gain an in-depth understanding of consumers' perception regarding either direct or indirect entomophagy [100,101]. The rich data generated from this study could therefore function as a first step towards future studies that would aim to build quantitative research tools which can be administered to a larger population. The latter would enable the statistical analysis and generalization of results.

#### 4. Conclusions

This study aimed to provide insights into the factors affecting the acceptance of insect-based foods and the specific foods that could be explored further and possibly be developed and introduced to the Irish market or those other regions (outside Ireland) where such products are not available. Negative public view, preference for familiar foods, disgust, cultural barriers, disturbing entomophagy-related experiences, and serving size comparisons (insect vs. meat) were factors identified before the tasting session as having a negative impact on willingness to consume insects. A lack of insect-based food availability in Ireland emerged as the main obstacle among those willing to try them. However, a separate set of factors affected the willingness to consume insect-based foods following the tasting sessions. These were related to participants' usual food choice motives and the sensory properties and type of product. Information regarding the approval of insects as a novel food in the EU could potentially improve consumer willingness to consume them. Willingness to buy insect-based foods was found to depend on the price, how they are promoted, the ingredient list, the sensory properties, the type of product, food preparation knowledge, and the nutritional content. For those willing to consume insects as a protein source, their willingness to buy would have been affected by the percentage inclusion of insects in the product. Since food choice motives affected the acceptance of insect-based foods among participants, investigating consumers' usual buying and consumption patterns could provide an indication of how they would receive such foods. Interventions through demonstrations by professional chefs, television programs that promote insect consumption, the introduction of tasting sessions to the general public, educational, and marketing strategies could potentially increase the willingness of consumers to buy insect-based foods. Future studies may build on the current findings and explore the views of more consumers in regions (including those outside Ireland or the EU) where insect-containing foods are not widely available to support future efforts aimed at encouraging environmentally sustainable and healthy food consumption.

**Supplementary Materials:** The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/challe15040040/s1>: Figure S1: An illustrative screenshot sample (first page) of the EU market screening conducted for the insect-based foods that could be delivered in Ireland; Table S1: Questions used in the protocol of the current study; Table S2: The extent to which participants (N = 17) liked/disliked the insect-based foods tasted based on their overall liking scores; Table S3: The extent to which participants (N = 17) were willing to buy the insect-based foods tasted.

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**Data Availability Statement:** The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical reasons.

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