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Scientific paper

How method of killing crickets impact the sensory qualities and physiochemical properties when prepared in a broth

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Abstract

Due to the increasing demands on the global food supply, entomophagy is being strongly considered as a viable alternative to protein derived from traditional animal sources. This study evaluated the sensory and physiological properties of a broth made from crickets that were frozen prior to cooking and compared it to a broth made from crickets that were alive when cooked. To Evaluate and compare how method of killing crickets impacts their sensory qualities and physiological properties, two experiments were conducted.

The first experiment consisted of three broths that were made, with different ratios, by weight; of frozen crickets to water (1:10, 2:10, 3:10) each sample contained ninety grams of mirepoix and four grams of salt. This experiment was conducted to establish a control recipe for final sensory analysis. From this experiment it was determined through a ranked preference test; that the ratio of 2:10 was adequate for the sensory analysis. For the final experiment, two broths were made in a similar fashion as described above. The first, being the control broth, made from crickets that were frozen prior to cooking and a variable broth made from crickets that were still alive prior to cooking.

A sensory evaluation was conducted comparing overall liking, and the perception of saltiness, bitterness, sweetness, sourness, and umami. Significant differences were observed in the pH level, overall liking, and the perception of saltiness, and umami. These results could be directly related to the break down of glycogen as well as from the formation of lactic acid. In part, these results are completely opposite from what consumers prefer in products from larger animals. These finding can be of importance when considering future processing methods of insect based proteins and consumer dietary needs such as low sodium foods.

Keywords: Cricket; Entomophagy; Glycogen; Glycolysis; Lactic Acid; Low pH; Stress

Introduction

The security of the worlds food supply is coming into question; as the world's population continues to grow, the supply of food will continue to decline. Gahukar (2011) By the year 2050, it is estimated that the world will be host to approximately 9 billion people. Alexandratos and Jelle (2012) With this estimated population growth, alternative sources of protein that can be economically and ecologically sustainable are being looked into. Ramos-Elorduy (1997) One reason for this change is traditional sources of protein (large mammals) are expensive to rear and inefficient in transforming plant biomass into animal biomass partially due to their need for sustained body temperature. Lindroth (1993) Therefore, a potential source for sustainable protein should come from a cold-blooded animal, such as Insects. DeFoliart (1992) Studies have shown that Insects, considered mini livestock, (Hardouin, 1995) have an extremely efficient feed conversion ratio (FCR) yielding a significantly higher edible weight over traditional livestock (Table 1), as well as having environmental benefits (Collavo et al., 2005; Flachowsky, 2002; Smil, 2002) Considered a renewable, inexpensive source of food, insects are also an excellent source of micro and macronutrients comparable to traditional animal proteins, (Beets, 1997) Despite the benefits of insects as an alternate source of protein, the current level of demand already surpasses current available supply. It is estimated that 28% of the world's population (2 billion people), rely on insects as a source of nutrition. Xiaoming et al. (2010).

Entomophagy is not a new concept in meeting the world's dietary needs. Archaeological evidence suggests that entomophagy has been practiced as long as humans have been on

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Table 1
Efficiencies of production for conventional meat and crickets.

Feed Conversion Ratio (FCR)	Cricket[a,b]	Poultry[c]	Pork[c]	Beef[c]
Kilogram feed: Kilogram live weight	1.7	2.5	5	10
Edible portion (%)	80	55	55	40
Feed (Kilogram: Kilogram edible weight)	2.1	4.5	9.1	25

[a]Collavo et al., 2005.
[b]Nakagaki and DeFoliart, 1991.
[c]Smil, 2002: Lindroth, 1993.

earth. Chen et al. (2009) In China, for example, insects have been eaten for over 3000 years (Chung, 2010) while in Thailand, edible insects are widely accepted throughout every socioeconomic class with annual revenue from sales that is greater than 6 million (U.S.) dollars. Gorton (1988) Currently, Insects are seriously being considered for use in manned space habitation as a means of a sustainable food source. Katayama et al. (2006) Excluding western societies, it is estimated that almost 2000 species of insects are currently consumed throughout the world (MacEvilly, 2000) This trend can be attributed, in part, to the economical disadvantages these nations have; however, as the world's population continues to grow, it will become increasingly unsustainable for the western world to continue to rely on traditional animals as a primary source of protein. Jarosz (2009).

One foreseen obstacle of introducing entomophagy into the western diet is the neophobic attitude towards foods that are unfamiliar (DeFoliart, 1999; Paterson, 1993), despite inadvertently eating them in common processed foods such as peanut butter, chocolate, wheat flour. Gorham (1979) Interest in entomophagy is mainly from a novelistic approach. Gordon (1998) Education on the benefits associated with entomophagy can reduce the aversion towards insects, and is believed to be the best course of action for its success (Mignon, 2002).

One belief is that if insects are raised to gourmet food status, demand will follow. Durst et al. (2010) This theory can be supported by the change in attitude towards lobster that occurred in the late 19th century,(Gracer, 2010) and exemplified with the emergence of insects on the menu in restaurants such as NOMA, in Denmark, and D.O.M. located in Brazil. For the conventional food industry, extracted insect proteins could be used in preformed foods, such as patties or sausages, which are familiar to the western consumer. (Birgit and Oliver, 2013; Topham, 2014).

Some insects may prove suitable for industrial-scale mass production. Kok et al. (1991) Because of their nutritional value, taste, and ease of rearing, crickets would make a good candidate. Research has shown that crickets have some of the highest protein levels when compared to other insects as well as high quality fatty acids. Van Huis et al. (2013) Studies have shown that their nutritional value can also be increased through augmentation of their diet. Allen and Olav (1989) Aside from protein content, crickets contain high levels of essential minerals (Table 2) as well as insoluble fiber and glutamic acid (Koide, 1998; Yoloye, 2010) These properties would also allow crickets to enter our food system directly to augment

Table 2
Essential mineral content of crickets (mg/kg)[6].

Parameter	Cricket
Cu	69.05 ± 0.70
Fe	519.00 ± 44.5
Mg	1538.77 ± 27.47
Co	2.07 ± 0.70
Zn	256.55 ± 28.70
Na	156.25 ± 5.30
K	282.80 ± 17.88

(Bankole, 2013).

current foods and diets lacking in essential minerals and nutrients, (Alexandratos and Jelle, 2012) or indirectly in the form of animal feed (Barker et al., 1998; Tranter, 2013).

With the prospect of introducing insects into our diet, consumer acceptance is paramount as well as the safe and effective means of cultivating them. Ramandey and Henk van (2010) Another concern could be their ethical and humane treatment. Studies have shown that insects react to what humans consider painful or irritating stimuli; additionally, It has been suggested that some invertebrates have cognition of pain but to what extent they experience nociception is unclear (Hwang et al., 2007).

This gap in knowledge will be of importance in large-scale harvest and slaughter methods.

It has been shown in many studies that ante-mortem stress negatively influences physiological and hedonic properties of meat (Hendricks, 1965) from traditional sources such as avian, (Abdalla et al., 1999) porcine,(Brown et al., 1998) ruminants, (Ferguson and Warner, 2008) and fish. Diouf and Rioux (1999) In addition to vertebrates, ante-mortem stress has been shown to affect invertebrates (Momoyama and Matsuzato, 1987) such as such as crabs, (Barrento et al., 2010) various species of lobsters (Chang, 2005), penaeid shrimp species, (Paterson, 1993) and freshwater crayfish. Jackson et al. (2001) These studies should lend insight into the causation of similar results in food systems containing insects.

The purpose of this experiment was to examine how the method of killing crickets impacts their sensory qualities and physiochemical properties when prepared in a broth. The reason an aqueous food system was chosen for this experiment was to mitigate neophobic aversions from panelists conducting sensory evaluation. Additionally, this method reduced variances in samples that were tested due to the nature of a broths ability to be prepared with minimal ingredients.

Materials and methods

To Evaluate and compare how method of killing crickets impacts their sensory qualities and physiological properties, two experiments were conducted. The first consisting of three broths that were made, with different ratios, by weight, of crickets to water (1:10, 2:10, 3:10). These ratios were evaluated in a

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