Fortification of a Ready-to-Eat Therapeutic Food Using Cricket Protein Hydrolysates

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ABSTRACT

Over the past 4 years, world hunger has been increasing. This is likely a result of the Covid-19 pandemic and its aftermath. In 2019, 8% of people were affected by hunger. By 2022, that number had climbed to 9.8% **[14].** It is estimated that it will take until 2030 to bring this number back down to 8%. The majority of world hunger is concentrated in areas in Africa and Western Asia **[14].** These areas are susceptible to devastating droughts, which can contribute heavily to the hunger issues they experience. Children are disproportionately impacted by malnutrition, and hunger often begins to affect children while they are in the womb. Because of this, it is important to provide adequate nutrition for pregnant and breastfeeding mothers. Ready-to-eat therapeutic foods (or RETF's) are nutrient-dense foods that are used to treat severe acute malnutrition. Most of these foods on the market today are made with milk protein, which can be hard to come by in times of drought. A solution to this problem could be to use cricket protein as an alternative to milk.

Crickets take less water than cattle do to grow **[3].** They can be farmed during droughts and can live off of food scraps and crops that can be grown locally in arid regions. Due to the advantages of using crickets as a source of protein, our main objective was to formulate a protein-fortified RETF for pregnant and breastfeeding mothers to combat severe acute malnutrition. Three formulations were made. One formulation (our control) was made with milk protein (2.1% wheat germ, 0.1% salt, 38% peanut butter, 15.2% milk powder, 13.7% brown rice powder, 30.4% corn syrup, and 0.4% cardamom) and one was made with cricket protein hydrolysates (CPH) (2.1% wheat germ, 0.1% salt, 38% peanut butter, 15.2% CPH, 13.7% brown rice powder, 30.4% corn syrup, and 0.4% cardamom). After our initial test, the CPH formulation was reformulated to increase acceptability in flavor and texture (2.0% wheat germ, 0.1% salt, 36.2% peanut butter, 11.6% CPH, 17.5% peanut butter powder, 29.0% corn syrup, 3.6% sugar). Panelists preferred the formulation made with milk protein in the first trial but showed fairly low acceptability for both formulations. In the second trial, only the reformulated CPH RETF was given to panelists and showed a much higher acceptability.

SIGNIFICANCE

The facts about severe malnutrition:

- Malnutrition of pregnant and breastfeeding mothers can cause serious health complications and even death for both mothers and their babies **[9]**.
- Proper nutrition for mothers during pregnancy can greatly reduce the occurrence and severity of malnutrition in babies and children.

The facts about cricket protein:

- Crickets take only take 44-54 days to reach maturity after eggs are laid **[7]**.
- Crickets are made up of 55-73% protein **[9]** whereas milk powder is only 34-37% protein **[11]**

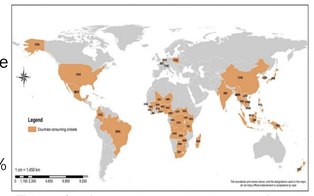

Figure 1. Places where crickets are already eaten around the world **[9]**.

The facts about drought and hunger:

- Only one gallon of water is needed to produce one pound of crickets **[2]**. In contrast, a dairy cow must drink a half gallon of water to produce one gallon of milk **[6]**. Although this is less water, only 3.5% of the liquid milk is made up of protein **[5]**.

Figure 2. Image of a house cricket, *Acheta domesticus* **[4]**.

- Hunger and malnutrition affect people more frequently in areas where droughts are experienced. This is because lack of water makes crops harder to grow and livestock (like dairy cattle) harder to keep alive **[14]**.

INTRODUCTION

- Growing rates of world hunger demonstrate the need for efficient, sustainable, cost-effective solutions for treating malnutrition **[15]**.
- Ready-to-eat therapeutic foods are used to treat severe acute malnutrition in children around the world, and most are formulated using powdered milk, peanuts, butter, vegetable oil, sugar, and vitamins **[13]**.
- Incomplete nutrition in pregnant mothers can lead to low birth weight, which can cause greater risk for type 2 diabetes, obesity, and heart disease later on in the baby's life **[12]**.

Figure 3. Freeze Dried CPH

- An objective of our experiment was to make our RETF have a good acceptability when it comes to taste and texture, as this has been a difficulty with commercially available RETF's **[1]**.
- Hydrolyzing cricket powder to make cricket protein hydrolysates (CPH) allows the proteins to be digested more easily and for more protein to be utilized by the body **[8]**.
- The **objective** of this study was to develop a RETF formulation using CPH that would be acceptable for use to treat pregnant and breastfeeding mothers for malnutrition.
- The use of CPH is practical for use in drought-susceptible regions due to the small amount of water needed to farm crickets and the nutritional completeness of crickets.

EXPERIMENTAL

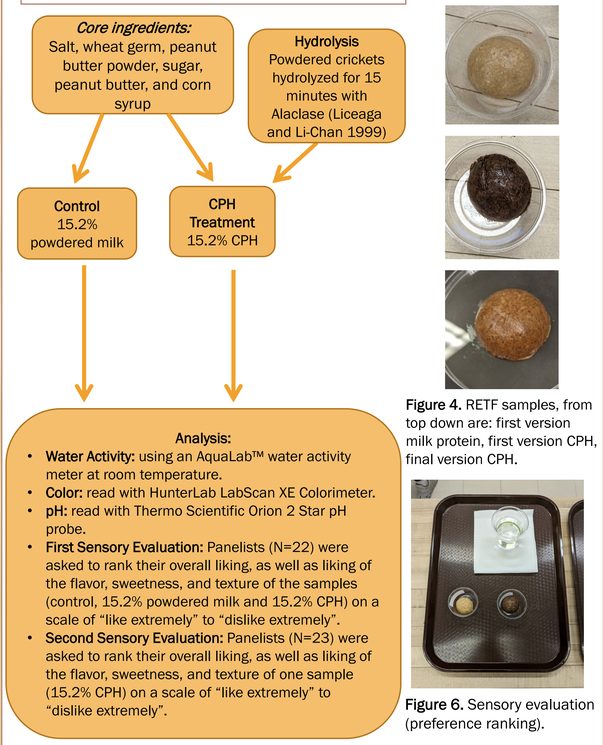

Figure 4. RETF samples, from top down are: first version milk protein, first version CPH, final version CPH.

Figure 6. Sensory evaluation (preference ranking).

RESULTS

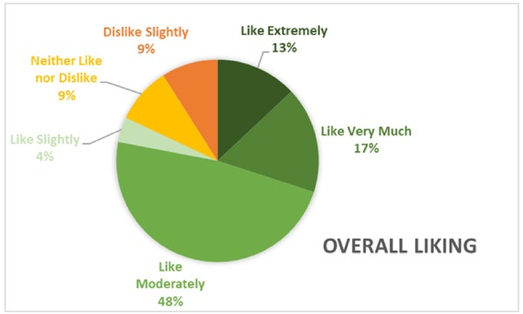

Figure 5. Preference ranking test results for overall liking of final version of RETF (n = 23 panelists).

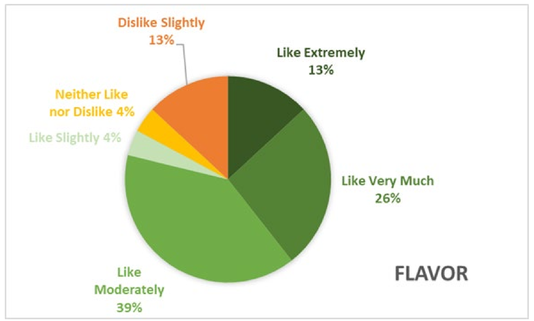

Figure 6. Preference ranking test results for flavor of final version of RETF (n = 23 panelists).

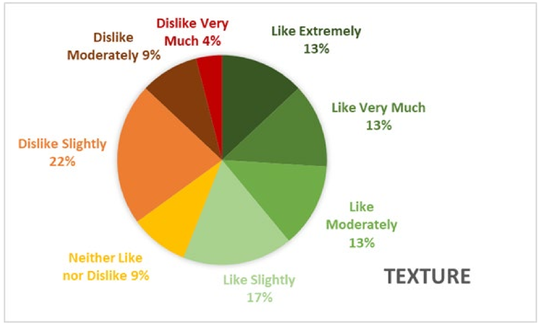

Figure 7. Preference ranking test results for texture for final version of RETF (n = 23 panelists).

Table 1. Physical property analyses results.

Analyses	
Water Activity	0.573 a_w
Color	(L*, a*, b*) = (31.23, 9.74, 22.51)
pH	5.88

DISCUSSION

- The first sensory evaluation was performed with 22 panelists. Each was given a sample of the milk powder formulation, a sample of the CPH formulation, and a cup of water on a tray.
- In the first sensory analysis preference test, panelists showed strong preference for the milk powder formulation and showed low acceptability for both formulations.
- Panelists from the first sensory evaluation commented that the texture of the RETF was too soft and that it didn't taste sweet enough.
- The color of the CPH formulation was off-putting to many of the panelists during the first sensory evaluation.
- For the second sensory evaluation, the recipe was improved by listening to the comments from the first preference test. Powdered peanut butter was added in place of brown rice flour, which had been in the first formulation in order to make the RETF a better texture and to add more flavor. Sugar was added to improve sweetness. A spice, cardamom, which had been in the samples in the initial sensory evaluation, was omitted in the second trial. The resulting version was sweeter, lighter in color, and was less soft/greasy,
- The second sensory evaluation was performed with 23 panelists, who were each given a sample of the CPH formulation and a cup of water.
- **Figure 5** shows the overall liking of the final version of the RETF. The majority of panelists liked the RETF to some extent (82%).
- **Figure 6** shows the liking for the flavor of the final version of the RETF. The majority of the panelists liked the flavor to some extent (82%) with 39% of panelists either liking extremely or liking very much the flavor.
- **Figure 7** shows the liking for the texture of the final version of the RETF. While the majority (56%) of panelists liked the texture to some extent, 35% of panelists disliked it.
- **Table 1** show the results of the physical property analyses of the final version of the RETF. The water activity was found to be 0.573 a_w . The colorimeter results showed the color coordinates of (31.23, 9.74, 22.51). The pH test showed that the pH of the sample is 5.88.

CONCLUSIONS

- A RETF was formulated using CPH and was shown to have good acceptability in taste trials.
- CPH are beneficial to use for an RETF because of the low amount of water required to farm crickets and the efficiency of crickets' growth.
- Additions of sugar and peanut butter powder were able to improve the flavor and texture of the RETF to be more acceptable to panelists in a sensory evaluation.
- While the overall likeability and the likeability of the flavor of the final version of the RETF were very high, the likeability of the texture of the sample was very low. This could be improved in future development.
- Samples were sent into a laboratory for proximate analysis, but results were not sent back in time to be published. In the future, proximate analysis, amino acid analysis, and shelf-life analysis would be beneficial.

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