PO-MU-MA Emergency food bar: nutritional, microbial, sensorial, and cost analysis

PO-MU-MA Barra de alimentos de emergência: Análise nutricional, microbiana, sensorial e de custos

PO-MU-MA Barra de alimentos de emergencia: análisis nutricional, microbiano, sensorial y de costes

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ABSTRACT
In 2015, 62.6 million women and children received food assistance in emergencies. However, they are usually provided with foods containing sufficient energy rather than a balanced diet. A nutrient-dense emergency food bar (PO-MU-MA) was made from local ingredients: potato (Solanum t.), mung bean (Vigna radiata l.), and malunggay
(Moringa o.) to optimize local foods and aimed to evaluate its sensorial acceptability, nutrient content, microbial load, moisture content, and cost analysis. An experimental design was used for the three (3) formulations with 25D consisting of 18g of potato and mung bean flour, 5.15 g of malunggay-infused water, and other ingredients. 99Z and Q2Y have the same ingredients but with potato flour and mung bean flour in different ratios, namely, 27g potato flour and 9g mung bean flour for 99Z and 9g potato flour and 27g mung bean flour in Q2Y. For appearance (color) and aroma, 99Z is the most acceptable. The acceptability in terms of taste is the same. For texture, Q2Y was chosen, as well as for overall acceptability. Nutrient analysis of the most acceptable product formulation showed an energy content of 461 kcal per 100g, sufficient to provide 22% of the Recommended Dietary Allowance for energy. The carbohydrate content per 100g is 56.25g, protein is 8.30g, and fat is 22.6g. For microbial load, yeast and mold are low (40 CFU/g), while E. coli and Salmonella are both negative, making the product safe for consumption. Furthermore, the food bar has a low moisture content (11%). For product costing, it shows that 100g of the product costs PHP 28.36. Generally, the PO-MU-MA Emergency Food Bar is recommended for food and nutrition needs in emergencies.

**Keywords:** emergency food bar, potato, mung bean, malunggay.

**RESUMO**

Em 2015, 62,6 milhões de mulheres e crianças receberam assistência alimentar em situações de emergência. No entanto, geralmente recebem alimentos que contêm energia suficiente, em vez de uma dieta balanceada. Uma barra alimentar de emergência rica em nutrientes (PO-MU-MA) foi feita com ingredientes locais: batata (Solanum t.), feijão mungo (Vigna radiata l.) e malunggay (Moringa o.) para otimizar os alimentos locais e teve como objetivo avaliar sua aceitabilidade sensorial, teor de nutrientes, carga microbiana, teor de umidade e análise de custos. Um desenho experimental foi utilizado para as três (3) formulações com 25D consistindo de 18g de farinha de batata e feijão mungo, 5,15 g de água com infusão de malunggay e outros ingredientes. 99Z e Q2Y têm os mesmos ingredientes, mas com farinha de batata e farinha de feijão mungo em proporções diferentes, ou seja, 27g de farinha de batata e 9g de farinha de feijão mungo para 99Z e 9g de farinha de batata e 27g de farinha de feijão mungo em Q2Y. Para aparência (cor) e aroma, 99Z é o mais aceitável. A aceitabilidade em termos de sabor é a mesma. Para textura, foi escolhido Q2Y, bem como para aceitabilidade geral. A análise nutricional da formulação do produto mais aceitável mostrou um conteúdo energético de 461 kcal por 100g, suficiente para fornecer 22% da Dose Diária Recomendada de energia. O conteúdo de carboidratos por 100g é 56,25g, a proteína é 8,30g e a gordura é 22,6g. Para carga microbiana, levedura e mofo são baixos (40 UFC/g), enquanto E. coli e Salmonella são negativos, tornando o produto seguro para consumo. Além disso, a barra alimentar possui baixo teor de umidade (11%). Para o custeio do produto, mostra que 100g do produto custa PHP 28,36. Geralmente, a Barra Alimentar Emergencial PO-MU-MA é recomendada para necessidades alimentares e nutricionais em situações de emergência.

**Palavras-chave:** barra alimentar de emergência, batata, feijão mungo, malunggay.

**RESUMEN**

En 2015, 62,6 millones de mujeres y niños recibieron asistencia alimentaria en situaciones de emergencia. Sin embargo, normalmente se les proporciona alimentos que
contienen suficiente energía en lugar de una dieta equilibrada. Se elaboró una barra de alimentos de emergencia rica en nutrientes (PO-MU-MA) a partir de ingredientes locales: papa (Solanum t.), frijol mungo (Vigna radiata l.) y malunggay (Moringa o.) para optimizar los alimentos locales y con el objetivo de evaluar su aceptabilidad sensorial, contenido de nutrientes, contenido de humedad y análisis de costos. Se utilizó un diseño experimental para las tres (3) formulaciones con 25D que consta de 18 g de harina de papa y frijol mungo, 5,15 g de agua con infusión de malunggay y otros ingredientes. 99Z y Q2Y tienen los mismos ingredientes pero con harina de papa y harina de frijol mungo en proporciones diferentes, a saber, 27 g de harina de papa y 9 g de harina de frijol mungo para 99Z y 9 g de harina de papa y 27 g de harina de frijol mungo en Q2Y. Por apariencia (color) y aroma, 99Z es el más aceptable. La aceptabilidad en términos de sabor es la misma. Para la textura, se eligió Q2Y, así como para la aceptabilidad general. El análisis de nutrientes de la formulación del producto más aceptable mostró un contenido energético de 461 kcal por 100 g, suficiente para proporcionar el 22 % de la cantidad diaria recomendada de energía. El contenido de carbohidratos por 100 g es de 56,25 g, de proteínas de 8,30 g y de grasa de 22,6 g. En cuanto a la carga microbiana, la levadura y el moho son bajos (40 UFC/g), mientras que E. coli y Salmonella son negativos, lo que hace que el producto sea seguro para el consumo. Además, la barra alimenticia tiene un bajo contenido de humedad (11%). Para el costeo del producto, muestra que 100 g del producto cuestan PHP 28,36. Generalmente, la Barra de Alimentos de Emergencia PO-MU-MA se recomienda para las necesidades alimentarias y nutricionales en emergencias.

Palabras clave: barra de comida de emergencia, papa, frijol mungo, malunggay.

1 INTRODUCTION

Natural disasters pose many problems. One of which is on food security responses. In 2015, 76.7 million people worldwide received a World Food Program (WFP) food assistance in emergencies. Among them, 62.6 million were women and children. However, they are usually provided with foods containing sufficient energy rather than a balanced diet.

According to Ladamay & Yunwoo (2014), food bars are high-calorie foods made from a mixture of several food ingredients enriched with nutrients formed into a solid and packed form. The majority of existing food bars use wheat flour as the main ingredient. One of the products used as flour is potatoes. Potato flour is made with whole potatoes, with the peel not removed most of the time and is rich in vitamins and minerals. A medium potato has 37 grams of carbohydrates (Potato Flour Market, 2023). On the other hand, mung beans (V. radiata L.) are one of the cheapest sources of plant protein and are good sources of minerals such as calcium, sodium, and high vitamins A, B & C. Mung beans can be used whole, as a paste, as sprouts, or as flour (Mung Bean Flour-
The Ultimate Guide, 2021). Furthermore, *Moringa oleifera*, commonly known as malunggay, is one of the world's most nutritious herbs. It has been identified that its leaves are associated with numerous health benefits, including medicinal and nutritional advantages (Popoola and Obembe, 2013).

Many studies have been conducted on the utilization of potato (*S. tuberosum*), mung bean (*V. radiata L.*), and malunggay (*M. oleifera*) in different food products. However, there are no existing studies on the utilization of these three ingredients together to make a product that can potentially be used during emergencies. Thus, the present study optimized the use of these local ingredients in making an emergency food bar. Moreover, this research will evaluate the acceptability, nutrient content, and microbial load including moisture and product cost of potato and mung bean flour with malunggay-infused water as an emergency food bar, and compare to WHO-Food and Nutrition Needs in Emergencies’ average minimum energy requirement and the Emergency Ration Bar and Operational Diets based on the study of the properties of Compact Food Bars by Hadi et al. (2018).

2 OBJECTIVES OF THE STUDY

The general objective of this study was to formulate a nutrient-dense emergency food bar (PO-MU-MA) from potato (*S. tuberosum*) and mung bean (*V. radiata L.*) flour with malunggay-infused water (*M. oleifera*).

It specifically aimed to:
1.) Assess the level of acceptability of PO-MU-MA Emergency Food bar in terms of appearance (color), aroma, taste, texture, and overall acceptability;
2.) Analyze the nutrient content of the most acceptable emergency food bar made from PO-MU-MA Emergency Food Bar and compare it with the set standard of the nutritional content of the Emergency Food Bar;
3.) Evaluate the microbial load, including the moisture content of the most acceptable food bar made from PO-MU-MA Emergency Food Bar; and
4.) Determine the production cost of PO-MU-MA Emergency Food Bar per 100g.
3 METHODOLOGY/ MATERIALS AND METHODS

The study used the following tools and equipment: measuring spoon, dry and liquid measuring cups, kitchen/dietary scale, silicone baking molder, mixing bowl, metal and rubber spatula, sifter, baking tray, blender, wok, dehydrator, pulverizer, and oven. The ingredients were as follows: Granola potato (*S. tuberosum*), Kusapo mung bean (*V. radiata* L.), and malunggay (*M. oleifera*)-infused water. Complementary materials are butter, sugar, powdered milk, and baking soda which are easily accessible in the market.

An experimental design was used to formulate the different proportions of Granola potato (*S. tuberosum*), Kusapo (PSB MG2 or VC 3876) mung bean (*V. radiata* L.), and malunggay (*M. oleifera*) in making PO-MU–MA Emergency Food Bar. Granola potato, which is a variety that is massively produced in the locality was utilized. The main ingredients of the PO-MU-MA Emergency Food Bar including potato and mung bean were purchased from the Trading Post of La Trinidad located at the back of the Municipal Hall of La Trinidad Benguet. Meanwhile, malunggay leaves were collected in Cervantes, Ilocos Sur, and transported to La Trinidad since malunggay grows well in Ilocos soil (Adriano, 2018). To ensure the freshness and cleanliness of malunggay leaves, they came directly from the farm before processing.

3.1 POTATO FLOUR MAKING

In preparing the potato flour, procedures given by Rady et al. (2017) and Stewart (2022) were followed. The trial for the ratio of fresh potato to flour used 3000g of fresh potato with a yield of 500g flour. From this, the amount of fresh potato to be used for the three (3) formulations (54g): 18g, 27g, and 9g respectively was computed. Potato flour amounting to 54g was then multiplied by sixty (60) panelists to compute the total flour that is needed. Below are the steps done following the making of potato flour (Figure 1).
3.2 MUNG BEAN FLOUR-MAKING

The PSB MG2 (VC3876) locally known as ‘Kusapo’ is one of the common mung bean varieties farmers planted (Gregorio et. al, 2021). To make mung bean flour, the steps given by Bake with Paws (2019) were used as an alternative. Shown below are the steps in Mung Bean Flour Making (Figure 2).

3.3 PREPARING THE MALUNGGAY-INFUSED WATER

The preparation of malunggay leaves followed the seven steps of Pascual (2019).
3.4 FOOD BAR FORMULATIONS

Three (3) variations were used. Each formulation was tested for organoleptic properties. The recipe prepared by Murdiani et al. (2022) was followed and modifications to other raw materials to vary the formulation of the potato flour, mung bean flour, and malunggay-infused water referred to as 25D, 99Z, Q2Y, and incorporated other ingredients as detailed in Table 1.

The formulations were set based on the emergency food Nutrition Adequacy at 2100 kcal/day, of which 40–50% carbohydrates from potato, and 10-12% protein from mung bean to maintain the nutritional status of individuals with light Physical Activity Level (PAL), and children and women including the lactating and pregnant (World Health Organization, 2002; Mahendradatta et al., 2020; Sphere Project, 2014).

Table 1. Details of PO-MU-MA Emergency Food Bar Formulations

<table>
<thead>
<tr>
<th>FORMULATION</th>
<th>MIXING RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>25D</td>
<td>18g Potato Flour + 18g Mung bean flour + 20g Sugar + 8g Powdered Milk + 31g Butter + 5.15g MIW + 0.15g Baking soda</td>
</tr>
<tr>
<td>99Z</td>
<td>27g Potato Flour + 9g Mung bean flour + 20g Sugar + 8g Powdered Milk + 31g Butter + 5.15g MIW + 0.15g Baking soda</td>
</tr>
<tr>
<td>Q2Y</td>
<td>9g Potato Flour + 27g Mung bean flour + 20g Sugar + 8g Powdered Milk + 31g Butter + 5.15g MIW + 0.15g Baking soda</td>
</tr>
</tbody>
</table>

*MIW (Malunggay-Infused Water)
Source: by the authors.

3.5 MAKING OF PO-MU-MA EMERGENCY FOOD BAR

Figure 4. Steps in Making an Emergency Food Bar
Source: Fatmah et al., 2021
3.6 SENSORIAL ACCEPTABILITY OF PO-MU-MA EMERGENCY FOOD BAR

The attributes used for product acceptance include appearance (color), aroma, taste, texture (tender, moist, and crumb), and overall acceptability. The hedonic scale was 1-9 with a scale of 1=Dislike Extremely, 2=Dislike Very Much, 3=Dislike Moderately, 4=Dislike Slightly, 5=Neither Like nor Dislike, 6=Like Slightly, 7=Like Moderately, 8=Like Very Much, and 9=Like Extremely. Table 2 indicates the statistical limit and descriptive equivalent used in the study.

<table>
<thead>
<tr>
<th>Statistical Limit</th>
<th>Category</th>
<th>Descriptive Equivalent</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.13- 9.00</td>
<td>9</td>
<td>Like Extremely</td>
<td>Acceptable</td>
</tr>
<tr>
<td>7.24-8.12</td>
<td>8</td>
<td>Like Very Much</td>
<td>Acceptable</td>
</tr>
<tr>
<td>6.35-7.23</td>
<td>7</td>
<td>Like Moderately</td>
<td>Acceptable</td>
</tr>
<tr>
<td>5.46-6.34</td>
<td>6</td>
<td>Like Slightly</td>
<td>Acceptable</td>
</tr>
<tr>
<td>4.57-5.45</td>
<td>5</td>
<td>Neither Like nor Dislike</td>
<td>Not Acceptable</td>
</tr>
<tr>
<td>3.68-4.56</td>
<td>4</td>
<td>Dislike Slightly</td>
<td>Not Acceptable</td>
</tr>
<tr>
<td>2.79-3.67</td>
<td>3</td>
<td>Dislike Moderately</td>
<td>Not Acceptable</td>
</tr>
<tr>
<td>1.90-2.78</td>
<td>2</td>
<td>Dislike Very Much</td>
<td>Not Acceptable</td>
</tr>
<tr>
<td>1.00-1.89</td>
<td>1</td>
<td>Dislike Extremely</td>
<td>Not Acceptable</td>
</tr>
</tbody>
</table>

Source: by the authors.

The sensory acceptability test of the food bar included 60 young adult women ages 18-30 years old as panelists. Before actual testing, all panelists were asked to read and sign an informed consent form. After that, they were asked to consume a total of three samples with 5g each of the PO-MU-MA Emergency Food Bar formulations and complete a questionnaire regarding the four attributes [appearance (color), aroma, taste, and texture] and overall acceptability.
3.7 NUTRIENT ANALYSIS AND COMPARISON TO EMERGENCY FOOD QUALITY STANDARDS

One sample weighing 300g of the most acceptable formulation of PO-MU-MA Emergency Food Bar was brought to the First Analytical Services and Technical Cooperative (F.A.S.T. Laboratories) at Angeles City, Pampanga for Nutritional Analysis.

Table 3 indicates the Recommended Daily Allowance of Energy based on WHO-Food and Nutrition Needs in Emergencies. To determine whether the energy and macronutrient contents are appropriate to be consumed for emergency needs, the result of the nutrient analysis of macronutrients for the most acceptable formulation was compared to WHO-Food and Nutrition Needs in Emergencies’ average minimum energy requirement and the Recommended Dietary Allowance of Emergency Ration Bar and Operational Diets based on the study of the properties of Compact Food Bars by Hadi et al. (2018) as shown in Table 3.

Table 3. Levels of Energy and Macronutrients Based on RDA of Emergency Ration Bar (Hadi et al., 2018)

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>RDA*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>2100</td>
</tr>
<tr>
<td>CHO (g)</td>
<td>230</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>70</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>100</td>
</tr>
</tbody>
</table>

*RRecommended Dietary Allowance
Source: by the authors.

3.8 MICROBIAL LOAD TESTING

A sample weighing 200g of the most acceptable formulation of PO-MU-MA Emergency Food Bar was sent for Spread Plate, Conventional/API 20e, and IMViC to test for the Yeast & Mold, Salmonella, and E. Coli, respectively, at F.A.S.T. Laboratories at Angeles City, Pampanga.
3.9 PERCENTAGE OF MOISTURE CONTENT

Results of the Nutrient Analysis on the carbohydrate content of PO-MU-MA Emergency Food Bar were used to compute the moisture content. Percentage moisture was computed using the formula:

$$\text{% Moisture} = \frac{(\text{Tw} - \text{Dw})}{\text{Tw}} \times 100$$  \hspace{1cm} (1)

Where:

- Tw = Total Weight of Product
- Dw = Dry Weight

3.10 PRODUCT COSTING

The method of product costing for the most acceptable formulation of PO-MU-MA Emergency Food Bar used cost–plus profit pricing. Cost-plus pricing is a pricing strategy that adds a markup to a product's original unit cost to determine the final selling price (Campbell, 2020) using the formula:

Selling price = Costs + Profit Margin

Where costs include the following:

a.) raw materials cost
b.) overhead cost; and
c.) labor cost

3.11 TREATMENT OF DATA

Data analysis of the hedonic test results was carried out utilizing Statistical Packages for Social Statistics (SPSS) using the Friedman Chi-square statistics by the BSU- Office of the Research Services (ORS). Results on the sensory evaluation for appearance (color), aroma, taste, and texture were analyzed to determine the best
formulation and the panelist’s acceptance of the food bar. A summary of raw data was sent to the office of the University-ORS before the nutrient analysis. To determine if the most accepted formulation of PO-MU-MA Emergency Food Bar passed the standard of emergency foods, the results of the nutrient analysis were compared to the WHO-Food and Nutrition Needs in Emergencies’ average minimum energy requirement during Phase 1 of the emergency and the Recommended Dietary Allowance of Emergency Ration Bar and Operational Diets based on the study of the properties of Compact Food Bars by Hadi et al. (2018). Moreover, results from the Microbial test and Moisture Content were tabulated to present the microorganisms present and water content that may affect the safety of the product. Also, the cost of the product per 100g was determined.

4 RESULTS AND DISCUSSION

4.1 ACCEPTABILITY OF PO-MU-MA EMERGENCY FOOD BAR

Three (3) variations of the PO-MU-MA Emergency Food Bar referred to as 25D, 99Z, and Q2Y were evaluated for their organoleptic properties to assess the level of acceptability among young adult women as panelists. 25D consists of 18g potato and mung bean flour, 5.15g malunggay-infused water, and other ingredients. 99Z and Q2Y have the same ingredients but with potato flour and mung bean flour having different ratios namely, 27g potato flour and 9g mung bean flour for 99Z, while 9g potato flour and 27g mung bean flour in Q2Y. The mean ratings for the different attributes evaluated, which include appearance (color), aroma, taste, texture, and overall acceptability are shown in Table 4.

<table>
<thead>
<tr>
<th>ATTRIBUTE (Color)</th>
<th>TREATMENT</th>
<th>MEAN</th>
<th>ACCEPTABILITY</th>
<th>FRIEDMAN CHI-SQUARE STATISTIC</th>
<th>p-Value</th>
<th>PAIRWISE COMPARISON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>25D</td>
<td>6.77</td>
<td>Like Moderately</td>
<td>17.051**</td>
<td>0.000</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>99Z</td>
<td>7.27</td>
<td>Like Very Much</td>
<td></td>
<td></td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>Q2Y</td>
<td>7.03</td>
<td>Like Moderately</td>
<td></td>
<td></td>
<td>ab</td>
</tr>
<tr>
<td>Aroma</td>
<td>25D</td>
<td>7.12</td>
<td>Like Moderately</td>
<td></td>
<td></td>
<td>ab</td>
</tr>
<tr>
<td></td>
<td>99Z</td>
<td>7.37</td>
<td>Like Very Much</td>
<td></td>
<td>0.028</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>Q2Y</td>
<td>6.97</td>
<td>Like Moderately</td>
<td></td>
<td></td>
<td>b</td>
</tr>
<tr>
<td>Taste</td>
<td>25D</td>
<td>7.08</td>
<td>Like Moderately</td>
<td></td>
<td></td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>99Z</td>
<td>7.38</td>
<td>Like Very Much</td>
<td></td>
<td>0.135</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>Q2Y</td>
<td>7.40</td>
<td>Like Very Much</td>
<td></td>
<td></td>
<td>a</td>
</tr>
</tbody>
</table>
4.1.1 Appearance (Color)

Results of the Sensory Evaluation in Table 4 showed that in terms of Appearance, there is a high level of significance (p<0.001) among the three formulations. The pairwise comparison values show that 99Z, with the highest mean rating of 7.27 and a DE (Descriptive Equivalent) of “Like Very Much,” is the most accepted formulation for this particular attribute.

Food scientists believe that color is an important component of food quality, along with flavor and texture (Gray, 2013). 99Z contains more potato flour than mung bean with a ratio of 27g:9g. This means that the color of the product is closely related to the yellow color of potatoes. The result of the current study agrees with the article in Alimentarium, a Nestle Foundation (2021), on The Color of Food, wherein the colors red, orange, and yellow are instinctively preferred over green and blue, which are often associated with oxidation and bitterness.

4.1.2 Aroma

In the present study, 99Z is the most acceptable formulation in terms of aroma and is significant (p<0.05) among the three formulations with a mean rating of 7.37 and a DE of “Like Very Much.” 99Z has more potato flour than mung bean flour (27g:9g).

The scent receptors in our nose can detect both flavors and aromas (Dough Wines, 2021). As mentioned by Farzin et al. (2023), food aromas contribute to the overall impression of food quality. According to the study of Morquecho-Campos et al.
(2019), odors signal information about a food’s composition and macronutrient content. Moreover, according to an article in SPICEography (2022) entitled “Potato Flour: A Nutritious Gluten-Free Flour Option,” Potato flour has a sweet, mild flavor. In formulation 99Z, a stronger odor of potato is noted. Therefore, the results agree with the characteristics of 99Z with more potato flour than mung-bean flour.

4.1.3 Taste

For the products’ taste, results of the present study showed that there is no significant difference between the three formulations, however, Q2Y has the highest mean rating of 7.40 which was rated “Like Very Much” followed by 99Z with a mean rating of 7.38. This means that the acceptability in terms of taste of the three formulations is the same.

4.1.4 Texture

For texture, the most acceptable formulation among the three formulations is Q2Y (9g:27g), with a mean rating of 7.38 and a DE of “Like Very Much,” followed by 99Z (27g:9g) with a mean rating of 7.10 and DE of “Like Moderately which are highly significant (p<0.001) from 25D.

Q2Y contains more mung-bean flour than potato flour. It is said that baked goods made with mung bean flour tend to be denser and have a stronger flavor and a coarser and grittier texture than potato starch which provides a lighter and fluffier texture (Higa, 2023; Wallace, 2021).

For overall acceptability, the most acceptable formulation which is significant (p<0.05) among the three formulations is Q2Y with a mean rating of 7.57 and a DE of “Like Very Much.” Thus, based on the overall acceptability, Q2Y was chosen as the most acceptable PO-MU-MA Emergency Food Bar formulation used for the nutrient analysis.

4.2 NUTRIENT CONTENT OF PO-MU-MA EMERGENCY FOOD BAR

From the three (3) variations of the formulations, PO-MU-MA Emergency Food Bar referred to as 25D, 99Z, and Q2Y which had undergone sensory evaluation, Q2Y,
the most acceptable formulation was brought to F.A.S.T. Laboratories for nutrient content evaluation to assess the energy, carbohydrates, protein, and fat content. Table 5 presents the results of the total energy and macronutrient composition of the PO-MU-MA Emergency Food Bar per 100g.

Table 5. Levels of Energy and Macronutrient Based on WHO-Food and Nutrition Needs in Emergencies and the RDA of Emergency Ration (Hadi et al., 2018)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Unit</th>
<th>RDA/Day</th>
<th>RESULT (PO-MU-MA)</th>
<th>% RDA</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>g/100g</td>
<td>2100</td>
<td>461.40</td>
<td>22.0</td>
<td>Computation</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>g/100g</td>
<td>230</td>
<td>56.25</td>
<td>24.4</td>
<td>Computation</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>g/100g</td>
<td>70</td>
<td>8.30</td>
<td>12</td>
<td>Kjeldahl</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>g/100g</td>
<td>100</td>
<td>22.60</td>
<td>22.6</td>
<td>Acid Hydrolysis-Mojonnier Extraction</td>
</tr>
</tbody>
</table>

*Recommended Dietary Allowance
Source: by the authors.

4.2.1 Energy

The PO-MU-MA Emergency Food Bar yields 461.4 kcal per 100g based on the results of energy computations from the total carbohydrates, protein, and fat. These values will provide 22% of the standard Recommended Dietary Allowance (RDA) of 2100 kcal of WHO (2002). Moreover, the energy content of the food bar goes along with the energy content ranging from 310-400 kcal of commercially produced Top 5 Best Survival Food Bars by Langer (2023), consumable for one meal of the day making it acceptable to be given during emergencies.

4.2.2 Carbohydrates, proteins and fats

Carbohydrate was obtained by subtracting the test results of ash, fat, moisture, and protein from 100g [CHO: 100 - (Ash+Fat+Moisture+Protein)]. The results of the study showed that the carbohydrate content of the PO-MU-MA Emergency Food Bar (Q2Y) per 100g is 56.25g. This amount will provide 24% of the RDA. Moreover, the
carbohydrate content of commercially produced Top 5 Best Survival Food Bars by Langer (2023) ranges from 43g-51g. Hence, the carbohydrate content of the PO-MU-MA Emergency Food Bar is more than the amount provided by the commercial food bar. Carbohydrate is the most crucial food energy source accounting for 40-80% of the macronutrient’s total energy intake.

For protein, the results of the nutrient analysis showed a protein content of 8.30g per 100g. This will provide 12% of the RDA. As per WHO guidelines for food and nutrition needs in emergencies, a day’s worth of emergency food should contain 2100 kcal of total energy, of which 10-15% is from protein. The main source of protein in the food bar is the mung bean.

According to Anguah et al. (2017), generally, foods higher in fat and sugar content have higher satiety, flavor, and palatability. The results of the analysis of the fat content of the emergency food bar (Q2Y) showed 22.6g per 100g which will provide 22.6% of the RDA per day.

4.3 MICROBIAL ANALYSIS OF PO-MU-MA EMERGENCY FOOD BAR

Q2Y, which contains 9g potato flour, 27g mung bean flour, 20g sugar, 8g powdered milk, 31g butter, 5.15g malunggay-infused water, and 0.15g baking soda, was the formulation that received the highest rating after the sensory evaluation. The same formulation was brought to F.A.S.T. Laboratories for microbial load analysis. The results of the microbial analysis are shown in Table 6.

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>E. coli</th>
<th>Salmonella (per 25g)</th>
<th>Yeast and Mold Count (CFU/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato-Mung bean-Malunggay Emergency Food Bar CP2304-2091 -01</td>
<td>Negative</td>
<td>Negative</td>
<td>40 (est)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Method</th>
<th>IMViC</th>
<th>Conventional-Presumptive</th>
<th>Spread Plate</th>
</tr>
</thead>
</table>

Source: by the authors.
According to the Advisory Committee for Foods and Dairy Products (ACFDP), ready-to-eat foods contaminated by these organisms, and their presence, even in small numbers, result in such foods being of unacceptable quality/potentially hazardous. The Food and Drug Administration- FDA (2013) stated that coliforms must be negative for E. coli. The result of the microbial analysis showed that the PO-MU-MA Emergency Food Bar is negative for E. Coli, making it safe for consumption. Moreover, the results of the present study showed that the PO-MU-MA Emergency Food Bar is also negative for Salmonella per 25g. Salmonella is a type of bacteria that can cause food poisoning. A negative result in the product indicates safety in food consumption.

Based on the Institute of Food Science and Technology (2021), counts of yeast and mold can be utilized in investigations into food decomposition as well as general hygiene indications. For the acceptable level of microorganisms for baked goods by the FDA (2013), the values are generally based on levels that are achievable under Good Manufacturing Practice (GMP) and should be within or not exceeding $10^2$ cfu/g. Furthermore, following the three target contamination levels (low, 10-100 CFU/g; medium, 100-1000 CFU/g; and high 1000-10 000 CFU/g) and an uninoculated control level (0 CFU/g) used in the collaborative study of Bird et. al (2019). The laboratory result showed that the Q2Y of the PO-MU-MA Emergency Food Bar has an estimated 40 Colony forming units per gram (CFU/g) which means that there are 40 estimated viable bacteria or fungal cells in a sample. This shows that the PO-MU-MA Emergency Food Bar is considered to have a low contamination level.

### 4.4 MOISTURE CONTENT OF PO-MU-MA EMERGENCY FOOD BAR

Moisture is an essential factor in food shelf life (Moore, 2020). Moreover, shelf life is important because it informs consumers when food is safe to consume. Table 7 shows the result for moisture content from the Nutrient Analysis on the carbohydrate content of the emergency food bar. Carbohydrate was obtained by subtracting the test results of ash, fat, moisture, and protein from 100g.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Unit</th>
<th>RESULT</th>
<th>% Moisture</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>g/100g</td>
<td>11.0</td>
<td>11</td>
<td>Vacuum Oven Drying</td>
</tr>
</tbody>
</table>

Source: by the authors.
Using a vacuum oven drying, the moisture content of the emergency food bar was found to be 11g per 100g. Dry or low-moisture foods contain less than 25% moisture. As computed, the PO-MU-MA Emergency Food Bar has 11% moisture. Moisture content influences shelf life because increased water in a product raises its susceptibility to microbes, which can rot and damage the food (Moore, 2020). This means that the product is less susceptible to microbes and thus increases shelf-life.

4.5 COSTING OF PO-MU-MA EMERGENCY FOOD BAR

Actual ingredients were used as the main basis for cost computation for the product. Table 8 shows the product cost per 100g of the most acceptable PO-MU-MA Emergency Food Bar formulation.

Table 8. Product Costing of Q2Y formulation of PO-MU-MA Emergency Food Bars per 100 grams

<table>
<thead>
<tr>
<th>PARTICULAR</th>
<th>ITEMS</th>
<th>QUANTITY</th>
<th>COST/UNIT (PhP)</th>
<th>TOTAL COST (PhP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingredients cost</td>
<td>Potato</td>
<td>495 g</td>
<td>150/500g</td>
<td>148</td>
</tr>
<tr>
<td></td>
<td>Mung Bean</td>
<td>1485 g</td>
<td>125/1kg</td>
<td>185.63</td>
</tr>
<tr>
<td></td>
<td>Malunggay</td>
<td>275.875 g</td>
<td>20/250g</td>
<td>22.07</td>
</tr>
<tr>
<td></td>
<td>Butter</td>
<td>1705 g</td>
<td>60/200g</td>
<td>511.5</td>
</tr>
<tr>
<td></td>
<td>Sugar</td>
<td>1100 g</td>
<td>46.50/500g</td>
<td>92.4</td>
</tr>
<tr>
<td></td>
<td>Milk</td>
<td>440 g</td>
<td>34.5/90g</td>
<td>168.67</td>
</tr>
<tr>
<td></td>
<td>Baking Soda</td>
<td>8.25 g</td>
<td>32/250g</td>
<td>1.056</td>
</tr>
<tr>
<td>Raw Material Cost</td>
<td></td>
<td></td>
<td></td>
<td>1129.33</td>
</tr>
<tr>
<td>Overhead Cost (15 % of RMC)</td>
<td></td>
<td></td>
<td></td>
<td>169.40</td>
</tr>
<tr>
<td>Profit Margin (1% of RMC)</td>
<td></td>
<td></td>
<td></td>
<td>11.29</td>
</tr>
<tr>
<td>Labor Cost (P50.00/hr x 5 (hours))</td>
<td></td>
<td></td>
<td></td>
<td>250</td>
</tr>
<tr>
<td>Total Production Cost</td>
<td></td>
<td></td>
<td></td>
<td>1560.02</td>
</tr>
<tr>
<td>No of Yields</td>
<td></td>
<td></td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>Total Production Cost per unit</td>
<td></td>
<td></td>
<td></td>
<td>28.36</td>
</tr>
</tbody>
</table>

Source: by the authors.

The total costs were obtained by adding all raw material costs of the ingredients used, Overhead Costs, and the Labor cost. The labor cost added was based on the daily
minimum wage rate of Benguet. 15% for overhead cost was used and an additional 1% for the profit margin. Results showed that 100 g of PO-MU-MA Emergency Food Bar costs 28.36 pesos.

5 CONCLUSIONS

Conclusively, the PO-MU-MA Emergency Food Bar was found to be acceptable regardless of the formulation.

1. The Q2Y with the composition of 9 g potato (S. tuberosum), 27 g mung bean (V. radiata L.) flour, and 5.15 mL malunggay (Moringa o.) - infused water was the most acceptable formulation with “Like Very Much” for both overall acceptability and general attributes.

2. The most acceptable formulation’s energy content is sufficient for one meal, and its total carbohydrate and fat content is within the standard RDA of the macronutrients for emergency food bars.

3. The microbial load for yeast and mold is low, while the E. coli and Salmonella are both negative. In addition, the percentage of moisture was low, which means lesser susceptibility to microbes, increasing shelf-life.

4. Product costing shows that 100g of PO-MU-MA Emergency Food Bar cost PHP 28.36.

Generally, the PO-MU-MA Emergency Food Bar is considered beneficial during emergencies as most of the requirements for food and nutrition needs in emergencies are met.

6 RECOMMENDATIONS

Based on the findings of the study, PO-MU-MA Emergency Food Bar is recommended to manufacturers and food processors such as Meals Ready to Eat (MRE) Philippines, DOST-FNRI, and the Philippine Chamber of Food Manufacturers, Inc. to adapt the product and produce technology for possible production for the provision of emergency food rations in case of disasters and emergencies.

Moreover, since the study only assessed its acceptability among young adult women, the proponents recommend similar research be carried out for the general population. Also, the nutritional analysis should be done on the other formulation for
comparison. Further research on other additional sources of protein must also be incorporated to be able to follow the guidelines of food and nutrition in emergency food bars since mung bean as the main source of protein is insufficient. Nutrient analysis for vitamin and mineral content is also recommended since malunggay (Moringa O.) was included to be a source of nutrients. In addition, proximate analysis for the other components can be tested as well.

In addition, since the PO-MU-MA Emergency Food Bar is designed for emergencies, shelf-life evaluation and storage protocols are also recommended.
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