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Quality evaluation of millet (*Panicum miliaceum*) instant cereal product in Cebu, Philippines

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Abstract

Millet is a collective term referring to several small-grained cereal crop plants belonging to the grass family which are used as human food and is considered an important staple in several countries in the arid and semi-arid tropics. With the increasing appreciation concerning the benefits of millet, there has been an inclination towards their consumption. Literature on the millet production, processing, and introduction of millet in the Philippines has been minimal, even though a few millet species are successfully grown in the Visayas region. This study was conducted to develop an instant cereal product from millet. This includes the milling of millet to powder, cooked, and packed for the desired amount. Five treatments representing five different concentration levels of millet (80%, 65%, 50%, 35%, and 20%) and five different concentration levels of powdered skimmed milk (20%, 35%, 50%, 65%, and 80%). A single factor experiment arranged in a complete randomized design (CRD) was used in the study. The study results showed that significant differences were noted in the sensory attributes in terms of colour, aroma, taste, flavour, mouthfeel, and the overall acceptability of the millet instant cereal product. The treatment with a concentration mixture of 20% millet and 80% powdered skimmed milk (4 g millet and 16 g powdered skimmed milk for a 30 g serving size) was considered the most acceptable. Proximate analysis of the millet instant cereal product showed that it contains 4.53±0.21 moisture, 2.60±0.03 ash, 0.34±0.08 crude fibre, 3.95±0.05 fat, and 8.61±0.11 crude protein. Based on the prevailing market price of millet ($4/kg) and skim milk powder ($3.5/kg), Treatment 5 had the least partial cost with $0.071 per serving size of 30 g. It can be noted that the lesser the amount of millet in the formulation, the better was the acceptability of each sensory attribute as evaluated, and the cheaper it was to produce the millet instant cereal.

1. Introduction

Cereals are species of the grass family that are cultivated for their seed to be used as food. Cereals are a low-cost source of food with high nutritional value. One type of cereal that has been used for centuries is millet. Most of the millet grain produced is used as human food. Millets are capable of growing in harsh climatic conditions like less rainfall, no fertilizer availability or any other facilities that are frequently recommended for farmers dealing with difficult circumstances (Rathore *et al.*, 2016). With this, millet is considered an important staple in a number of countries in the arid and semi-arid tropics. Millet is considered a good source of vital nutrients. Millet is considered on par or superior in comparison to major cereal grains such wheat, rice, maize, and sorghum grains (Kajuna, 2001). The benefits of millets such as high fibre content, richness in bioactive compounds, gluten-free proteins, and low glycemic index indicate that millets are suitable to be consumed as health food. These are a rich source of many nutrients and thus, promise an additional advantage for combating nutrient deficiencies in third world countries (Kumar *et al.*, 2018). The role of millet in designing modern foods like multigrain and gluten-free cereal products is well known (Saleh *et al.*, 2013). With the increasing appreciation concerning the benefits of consuming millet, there has been an inclination towards their consumption. Also, as the world population grows increasingly, the demand for a variety of food to

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feed and support the population also increases proportionately. At present, about 50% of the world's total calorie intake is derived directly from cereals (Awika, 2011). The increase in consumption of millet and other cereals indicates a need for a rise in food products to be developed, processed, and produced utilizing these cereal crops. In addition to being utilized as human food, millet is also used as animal feedstuff, seed, and others.

In the Philippines, millet production and processing have not been given much attention compared to other cereals such as rice and corn. Literature on the millet production, processing, and introduction of millet in the Philippines has been scanty, even though there are a few millet species successfully grown in the Visayas region. In Northern Cebu, there are some areas that have grown millet for several years (Borbon *et al.*, 2013). These areas are in the municipality of Tuburan, Catmon and Sogod. Borbon (2011) reported that the local farmers refer to it as "*Kabog Pakdas*", "*Kabog Pilit*", and "*dawa*". The local delicacies made from millet are the "*Budbod Kabog*", "*Bikong Kabog*", "*Kabog Valenciana*" and "*Bibingka*".

The few pieces of literature available regarding the development of millet in the Philippines created a need for more product development, production, processing and introduction of millet. As a response, this study aimed at formulating a product utilizing millet, such as the millet instant cereal, using different treatments. Instant cereals are generally looked upon favourably for their adaptability to the modern-day lifestyle which emphasizes speed, convenience, and nutritional benefit to a person's overall diet. Further, this study aimed at identifying which treatments are acceptable to the consumer panellists in terms of sensory parameters determined the proximate analysis of the most acceptable treatment of millet instant cereal and determined which formulation had the least partial cost among the treatments used in the study.

2. Materials and methods

2.1 Experimental design and layout

This study used a single factor experiment arranged in a complete randomized design (CRD). All the treatments were replicated three times. These involved five different concentration levels (w/w %) of the millet (80, 65, 50, 35, 20) and five concentration levels (w/w %) of powdered skimmed milk (20, 35, 50, 65, 80) as shown in Table 1.

2.2 Preparation of the sample

Grain preparation, which included purchasing, handling, cleaning, hulling, was done before the pre-processing. Inspection and subsequent sorting of millet were also done to separate millet with unacceptable quality.

Table 1. Treatments used in the processing of millet instant cereal.

Treatment Number	Level of Millet	Level of Skimmed Milk
T1	80% (16 g)	20% (4 g)
T2	65% (13 g)	35% (7 g)
T3	50% (10 g)	50% (10 g)
T4	35% (7 g)	65% (13 g)
T5	20% (4 g)	80% (16 g)

The processing of the product was done by following the general method described by Kelly and Smalligan (1975). Modifications were adapted to the process as consideration to the raw material, as shown in Figure 1. The processing steps involved: Pre-processing, Cooking, Cooling, Rolling, Drying, Cooling, Tempering, Flaking, Mixing, and Packing.

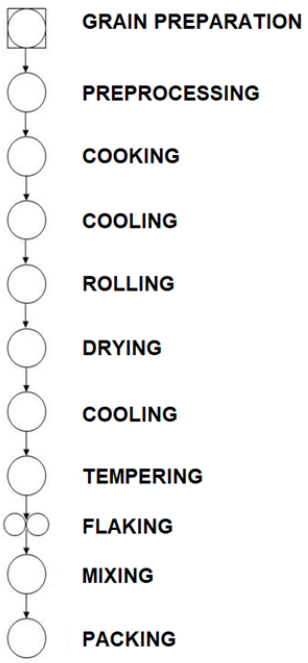

Figure 1. Process flow for millet instant cereal

The pre-processing step involved milling the millet to powder form. This was done to improve the texture or mouthfeel of the product. The millet grits were then cooked in a casserole for about fifteen to twenty minutes at 50°C or when it turns from a dark yellow colour to a soft translucent golden brown. Agitation was often done while cooking to distribute the heat evenly. When cooking was completed, the temperature was reduced to ambient conditions in order to cool the product.

Rolling of the cooked millet was done to flatten it after cooling so that it is the optimum size or thickness for drying. The cooled and rolled millet was dried at

temperatures below 70°C so as not to burn the product and to dry the millet to the desired moisture level. The product was again cooled to ambient temperature and then tempered by holding them in accumulating bins. This is done to allow the moisture content of the product to equilibrate between the grit particles as well as from the centre of the individual particles to the surface. After tempering, flaking was done to reduce the dried millet to the desired sizes. This was then mixed with a flavour solution that includes sugar, and different concentration levels of powdered skimmed milk. The product was packed in 0.3 mm thick polyethylene bags and stored at room temperature for sensory and other product evaluations.

2.3 Sensory evaluation

A consumer acceptability test was carried out to evaluate the sensory attributes of the product using a sensory score sheet. The colour acceptability, aroma acceptability, taste acceptability, mouthfeel acceptability, and overall acceptability of the product were evaluated by consumers using the 9-point Hedonic Scale by a consumer panel, which constituted of thirty breakfast cereal patrons. It was composed of students, professionals, and consumers that were willing to participate (Chambers and Wolf, 1996). Aside from those mentioned earlier, the consumer panel was also selected based on its ability to detect sample characteristics. The health of the potential consumer panel was an essential consideration since individuals with chronic sinus or colds and smokers are unable or have poor perceptions of flavour.

The consumer panel was oriented or briefed regarding the use of the sensory scorecards provided to them before they were subjected to the evaluation (Chambers and Wolf, 1996). Sensory terminologies like mouthfeel were discussed and defined for the panel to have a clear understanding of the evaluation parameters.

2.4 Proximate analysis

Proximate analysis such as moisture, ash, protein, crude fibre, and crude fat was determined. It was determined using the determined best treatment and was done in five replications. Proximate analysis was conducted using standard methods of the Association of Official Analytical Chemists (AOAC, 1995).

2.5 Product cost components

Partial product cost was done for all the treatments. Assuming all other ingredients to be constant, the computations of the partial product cost was based on the prevailing market price of the two varying ingredients, which is millet and skimmed milk powder. The following data were gathered: cost of millet per pack of instant cereal and cost of powdered skimmed milk per pack.

2.6 Data gathering and analysis

Data on the sensory acceptability of the product in terms of colour acceptability, aroma acceptability, taste acceptability, mouthfeel acceptability, and the overall acceptability of the consumer was gathered, and the means and percentages by criteria were computed. This was then analyzed statistically using Analysis of Variance (ANOVA). Through proximate analysis, the moisture, ash, crude protein or Kjeldahl protein, crude fibre, and crude fat were collected.

2.7 Statistical analysis

The data obtained from the sensory evaluation of the processed millet instant cereal was analyzed using the Analysis of Variance (ANOVA) at $p<0.05$. This was used to determine the significance of the effects of processing variables on the sensory attributes of the product. The Tukey HSD test was used to determine further which among the treatments that significantly differed based on the Analysis of Variance, significantly varied from each other.

3. Results and discussion

3.1 Acceptability

The Analysis of Variance (ANOVA) of the data on the sensory evaluation of the millet instant cereal in Table 2 showed that the treatments were significantly different from each other. Statistical analysis of the different parameters revealed that T5 with the mixture of 20% millet to 80% powdered skimmed milk was indicated to be the most acceptable treatment in terms of its colour acceptability, aroma acceptability, taste acceptability, mouthfeel acceptability, and overall acceptability.

Colour affects the acceptability of a product as it affects the perceptions of the consumer panellists. It is considered a critical aspect in the appearance of food and is oftentimes used as an index for acceptability (Varzakas and Tzia, 2015). The treatment with the lowest concentration of millet (T5) was rated the most acceptable. This is attributed to the browning experienced by the millet during processing. Also, the seed coat of the millet imparts a chewy texture and dark colour to the food products (Krishnan *et al.,* 2011). Having the least concentration of millet helped T5 appear less dark when compared to the other treatments. People generally value food products for their taste and the pleasant sensation is often contributed to the taste of

Table 2. Effect of different treatments on the acceptability of millet instant cereal

Treatment	Colour	Aroma	Taste	Flavour	Mouthfeel	Overall
T1	6.22±0.40^{a}	6.36±0.16^{a}	5.99±0.38^{a}	5.94±0.11^{a}	6.01±0.07^{a}	6.11±0.37^{a}
T2	6.50±0.13^{ab}	6.61±0.20^{ab}	6.46±0.12^{ab}	6.54±0.25^{b}	6.32±0.05^{a}	6.34±0.05^{a}
T3	6.77±0.17^{ab}	6.58±0.16^{ab}	6.58±0.24^{ab}	6.61±0.21^{b}	6.56±0.30^{bc}	6.63±0.12^{ab}
T4	6.67±0.26^{ab}	6.67±0.12^{ab}	6.77±0.37^{b}	6.72±0.21^{b}	6.57±0.19^{bc}	6.64±0.27^{ab}
T5	6.92±0.12^{b}	7.01±0.25^{b}	6.89±0.21^{b}	7.01±0.20^{b}	6.97±0.23^{c}	7.01±0.25^{b}

Values are presented as mean±SD. Values with the same superscript within a column are not significantly different from each other at $p<0.05$

the food. As observed, the treatments with the ratio of a relatively low percentage of millet to a relatively high percentage of powdered skimmed milk were rated the most acceptable in terms of the aroma, taste, and mouthfeel parameter.

In the overall sensory evaluation, it was found out that the treatment containing the mixture of 20% millet to 80% powdered skimmed milk (4 g millet to 16 g powdered skimmed milk) was the most acceptable to the panel of consumers. It can be noted that the lesser the amount of millet present in the formulation, the better is the acceptability of the sensory attribute. Hence, the higher the amount of millet in the instant cereal formulation resulted in a decreased acceptability on the conducted sensory evaluation.

The effect of adding or incorporating millet on the sensory acceptability of food products is limited. Reports available on the effect of millet on the acceptability of food products are mixed. There are researchers that have reported the increased acceptability of the products on the addition of millet. Also, there is available literature regarding the decreased acceptability of food products when added with millet.

A group of researchers performed a study on sorghum-based cookies. They reported that the cookies produced using 100% sorghum were evaluated as acceptable utilizing the 9-point Hedonic scale (Okpala *et al.,* 2013). A similar scenario was reported in a study done about baked products using millet. Popular bakery products such as biscuits, cakes, and cookies were developed using millet, and it was indicated that the bakery products mentioned were acceptable as a result of the sensory evaluation done (Shadang and Jaganathan, 2014).

On the other hand, Panghal *et al.* (2019) reported that the incorporation of finger millet flour in the whole wheat dough for whole wheat flatbread (chapatti) be negatively correlated and that the overall acceptability of whole wheat flatbread (chapatti) had decreased from 9.0±0.23 to 7.13±0.22. In another study that was based on extruded products prepared from sorghum flour, cornflour, whey protein isolate and defatted soy flour observed that there was decreased acceptability reported with the increased content of sorghum in the extruded products (Devi *et al.*, 2013).

3.2. Proximate analysis

From the results of the sensory evaluation, T5 was identified to be the best formulation for millet instant cereal, having a mixture of 20% millet to 80% powdered skimmed milk (4 g millet to 16 g powdered skimmed milk). Thus, this treatment was chosen to be the sample for proximate analysis. The analysis included five parameters and was replicated five times. Proximate analysis of the millet instant cereal as shown in Table 3 reveals that the product contains 4.53±0.21 moisture, 2.60±0.03 ash, 0.34±0.08 crude fibre, 3.95±0.05 crude fat, and 8.61±0.11 crude protein. Proximate composition is an important criterion to determine the nutritional values and quality of food (Qayyum *et al.*, 2012). Also, the low moisture content of the millet instant cereal is desirable for high moisture content in food products were indicated to promote the growth of microorganisms that causes reduction or loss of product quality and safety such as several spoilage microorganisms. The proliferation of these microorganisms reduces the shelf-life and stability of the food products causing unnecessary losses. Reported values for the millet instant cereal are higher than that of the reported values of Adebowale *et al.* (2014) for their cereal flakes made of rice flour and cereal flakes incorporated with a bit of Bambara nut flour. Obtained values for the protein, fat, and ash content are also comparable to the values of the corn cones cereal flakes reported by Cheewapramong *et al.* (2002).

Table 3. Proximate composition of the millet instant cereal

Nutritional Parameters	Value Content
Moisture	4.53±0.21
Ash	2.60±0.03
Crude Fat	3.95±0.05
Crude Fibre	0.34±0.08
Crude Protein	8.61±0.11

3.3 Partial cost analysis

Considering that all the other ingredients are

constant, the results of the partial cost analysis as shown in Table 4 indicate that T5 obtained the least partial cost with $0.071 per 30 g serving size. This was followed by T4 with a partial cost of $0.072. T3 and T2 partly cost about $0.074 and $0.075, respectively. The treatment with the highest partial cost was T1, with $0.077 per 30 g serving. This implies that the formulation for T5 containing 20% millet and 80% powdered skimmed milk in which it had the least amount of millet combined with the most amount of skimmed milk was the cheapest treatment of the millet instant cereal to produce. It can be inferred that the increasing amount of millet incorporation into the instant cereal formulation has an inverse effect on the partial cost of the instant cereal product.

Table 4. Partial cost of the millet instant cereal

Treatments	Level of Millet (in grams)	Level of Skimmed Milk	Partial Cost (for every 30 g
T1	16	4	$0.077
T2	13	7	$0.075
T3	10	10	$0.074
T4	7	13	$0.072
T5	4	16	$0.071

4. Conclusion

Based on the sensory attributes (colour, aroma, taste, mouthfeel, and overall acceptability) evaluated by the consumer panellists, T5 had a mixture of 20% millet and 80% powdered skimmed milk (4 g millet and 16 g powdered skimmed milk) was the most acceptable. It implied that the lesser the amount of millet in the formulation, the better was the acceptability of each sensory attribute as evaluated by the panellists. Proximate composition of the millet instant cereal confirmed that it contained 4.53±0.21 moisture, 2.60±0.03 ash, 3.95±0.05 crude fat, 0.34±0.08 crude fibre, and lastly, 8.61±0.11 crude protein. Partial cost analysis indicated that T5 formulation with 20% millet and 80% powdered skimmed milk (4 g millet and 16 g powdered skimmed milk) has the least cost among the treatments used in the study. Hence, the millet instant cereal following the formulation for T5 is the most cost-efficient to produce.

Conflict of interest

The authors declare no conflict of interest.

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