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PROCESSING OF INSTANT ADLAY-VEGGIE NUTRIMEAL

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Abstract — Tapol variety of adlay with addition of local vegetables was formulated into an instant nutrimeal. Product was evaluated as to its physico-chemical properties, rehydration properties, microbial load, sensory characteristics, and proximate analyses for the most acceptable formulation. Instant adlay nutrimeal was formulated with dehydrated adlay-moringa powder (12%), squash powder (15%), coco sugar (35%), red mungbean powder (10%) and non-dairy creamer (28%). Physico-chemical properties as pH, total soluble solids, moisture content and water activity (a_w) were determined while for rehydration properties were noted as solubility, dispersibility and sinkability at different temperatures. Flowability was also noted. Microbial count was determined through total plate and yeast and molds while sensory characteristics were evaluated by three panelist groups using descriptive and ranking tests. Proximate analyses and nutritional composition were determined using standard methods and sent to accredited laboratory.

Adlay nutrimeal characteristics showed that it has 15°Bx total soluble solids, pH of 6.5, moisture content of 5.25 to 7.21% and 0.481a_w. The product has good solubility, sinkability and dispersibilty at 70 to 90 C and has good flowability. Total microbial count of <10 log CFU/g while yeast and mold count was 2.78log CFU/g. Sensory properties showed that the product is light brown in color, with desirable aroma, moderately viscous to viscous consistency, and perceptible adlay-vegetable flavour. Acceptability was described as like very much by the high school students, partially-trained panelist while liked moderately by the elementary pupils. Proximate analyses showed 7.21% moisture content, 2.21% ash, 11.88% total fat, 6.33 % crude protein, 1.93% crude fiber and 72.37% carbohydrates by difference method. The product (55g) contains 230 calories, 40g carbohydrates, 7g fats, 3g protein and 5g other nutrients.

Keywords **— Adlay, instant, nutrimeal, veggie**

INTRODUCTION

Despite government efforts to reduce malnutrition, the Philippines is home to millions of malnourished children (Gupta, 2011). The results of the 2011 National Nutrition Survey of the Food and Nutrition Research Institute (FNRI) showed that malnutrition among children is still prevalent. In its latest study, FNRI revealed that almost one in every three Filipino children is underweight and under height or stunted for their age. The number of undernourished Filipinos increased by two million in the past two years (Roa, 2012).

Children suffering from undernutrition miss out on the vital nutrients that are needed not only to grow but also to build up immunity against diseases (www.philstar, 2012). To prevent children from becoming under-nourished and reduce the risk of stunting and diseases, their meals should have a balanced energy distribution in terms of macronutrients as well as other factors, such as carbohydrates, adequate quality protein, healthy fatty acid ratio, and adequate potentially deficient micronutrients (World Health Organization, 2003). With a balanced diet in consideration, nutritious and affordable meals containing ample amounts of these essential nutrients can be prepared within the limits of one's budget. Some of the causes and reasons of malnutrition are poverty, population, politics, production and preservation of food from wastage (Kreiβl, Alexandria, 2009). In a country rich in biodiversity, the effects of these causes and reasons may be lessened by utilizing every edible crop as food material or sources in its manufacture.

As part of the solutions to the malnutrition problem among Filipino children, the Malnutrition Reduction Program (MRP) of the DOST-FNRI addresses malnutrition through the adaptation of complimentary food technologies and intervention programs extended out to rural areas. Among these food innovations are complementary foods such as rice-monggo blend crunchies and curls for snacks and ready-to-eat food for infants and young children, as well as micronutrient growth mix.

Aside from the use of staple crops such as rice to combat malnutrition, indigenous crops are being utilized as food material and source in the manufacture of newly developed products. Dela Cruz (2011) in her article cites one important government program which could be a promising method to combat malnutrition is the promotion of adlay crop as a staple food.

Adlay (*Coix lacryma-jobi* L.) grains, also known as Chinese pearl barley, or Job's Tears, like rice, grows on long stalks of grass and is processed into ivory-colored beads with black or light-brown streaks (Jansen, 2006). Although it shares some characteristics with rice, it can be easily overlooked because of its grass-like appearance (Heime, 2015). Due to this, the crop blends well with other wild plants and has not gained popularity despite its astounding nutritive value. Recently, however, adlay has emerged as a potential alternative food source for rice. The crop is easy to cultivate, immensely nutritious, and has the possibility to alleviate the nation's food security issue. Due to this, the Department of Agriculture eyes adlay to be a potential emerging crop that can be utilized for food production and sold in the mainstream market in the future. Adlay grains can be ground into starch (Capule et al., 2016) and flour which can be used to make bread, pasta, and porridge (Dela Cruz, 2011).

The Bureau of Agricultural Research (BAR), tasked to look into the potential of the crop, has been conducting adaptability trials of varieties for seed production and commercialization of adlay. Adaptability trials aim to assess the performance of different adlay varieties in different locations and elevations. The Department of Agriculture sees adlay as a solution to

the country's chronic insufficiency as far as palay is concerned, results of adaptability trials will be beneficial for the farmers who want to grow the crop in a commercial range.

This research desires to expound on the versatility of adlay and contribute to its promotion as a viable alternative to rice and corn. In documentation conducted by the BAR in locations where the crop is grown in the same manner as rice and corn, it was found that adlay thrives best in high elevations and cool temperature, and soil of good fertility. The production practices are traditional, low-cost and environment friendly. No major pest attacks the crop and use of organic fertilizer results to profuse rooting and tillering. Should more products be developed from adlay its low farm input and low maintenance and cultivating cost may entice farmers in growing the crop (Dela Cruz, 2011).

To determine the adaptability of available varieties, develop technologies on cultural management practices, postharvest and processing, the BAR is supporting adaptability trials of adlay in Regions II, IV, V, and X (Mojica, 2011). Adaptability trials and seed production of adlay in the Bicol region has already been initiated at the experiment site of Bicol Agricultural Research Center (BIARC). Four varieties of adlay are tested – Gulian (white), Tapol (purple), Guinampay (dark brown) and Kiboa.

Field trial results noted that Tapol variety produces the highest yield (CBSUA Research, 2013; Adante, 2011), having yield of 1,283.92 kgs/ha or 38.91 cav/ha in July 2012-January 2013 field trial. To complement this program, another adaptability trial was also conducted at DA-10 (NOMIARC), Dalwangan, Malaybalay City, Bukidnon during CY 2010-2011, Tapol attained the tallest with 307.7 cm height and obtained more grains per panicle with 276.0. Moreover, sensory test revealed that, on texture and generally acceptability, Tapol had the highest rating among the varieties with 7.0 which means it was liked very much by the tasters (Tumampon et al., 2012). This variety is soft-shelled, glutinous and is edible hence, the choice as raw material for this study.

The grains of adlay are highly nutritious and found superior as compared to its staple counterparts when it comes to its macronutrient contents. According to Dela Cruz' (2011), a person who ate a cup of steamed adlay for lunch is built to last a whole day's work compared to those who ate rice. Apart from the nutritional value, the increased consumption and research to promote adlay will be of great benefit for the farmers who want to produce this crop in a commercial range as well as for the agriculture industry given our current challenge for rice sufficiency. Therefore, the nutritive economic value of adlay is substantial and worth studying.

For the same serving of rice and corn, adlay has three times more carbohydrates and five times more protein, not to mention the minerals contained in its grains such as calcium, phosphorus, iron, niacin and other essential minerals. As it is packed with both the macro- and micronutrients, the crop could be utilized as the main ingredient in the formulation of instant meal or the so called "nutrimeal" (Dela Cruz, 2011). In recent years, due its superior amount of carbohydrates, much attention has been drawn to the utilization of adlay grains in the formulation of instant cereal energy drink (Pellosis et al., 2017, Manning et al., 2017) and its combination with legumes such as soybeans (Wanawan, 2014).

Usha (2007) describes instant food or composite mix as a mixture of different foods or ingredients packaged as an instant source of nutrients needed by the human body. Composite mixes contain many ingredients which bring about improvement in nutritional composition and protein quality by mutual supplementation, in addition to

providing convenient ready-to-use product for the household (Kurahatti, 2010).

In this research an instant food mix or a nutrimeal was formulated from adlay grains. Nutrimeal, was prepared in this study, is a ready-to-eat meal prepared hot or cold. (AC Nielsen, 2006). It has adlay as its primary ingredient and other indigenous vegetables as nutrient and flavour enhancers. The food mix is formulated to meet the nutritional demand of both children and adults. The ease in its preparation as a food meal hopes to illustrate that adlay is a crop of value and worthy of cultivation just like its cereal counterparts.

An instant food mix with a palatable taste is a big leap in the introduction and promotion of adlay as a viable substitute food to alleviate malnutrition in the Philippines. This will further promote adlay as an emerging alternative crop for the agriculture industry given our current challenge for rice sufficiency of the realization that Nano-sized materials are more effective in a multitude of agricultural aspects (Nair et al., 2010).

This study developed an instant adlay-veggie nutrimeal utilizing powdered adlay grits as its raw material added with local vegetables. The study focused on the formulation and evaluation of instant adlay nutrimeal. Evaluation of the product was done through physico-chemical, microbial, rehydration, flowability, sensory properties. Proximate analyses and nutritional composition were determined to the most preferred formulation.

MATERIALS AND METHODS

The study employed Research and Development (R&D) method to meet the enumerated objectives of the study namely; to process adlay grits into an instant nutrimeal; to formulate adlay nutrimeal with other local commodity such as red mungbean, moringa and squash; to evaluate results through sensory, physico-chemical, proximate, and microbial analyses of the adlay nutrimeal; to determine the nutritional composition of adlay nutrimeal and to determine its commercial value as compared to other existing products.

The existing programs of the Department of Agriculture on the development of products from priority commodities (Brion, 2012) were used as a reference in the planning of this study. Adlay is listed as a primary commodity by the agency. Reference materials such as techno-guides, studies and researches previously conducted along the same line, were also utilized in the formulation. The researcher identified sources of the raw materials used in the conduct of the study and made sure of the availability of Tapol variety of adlay for product development.

Tapol variety of adlay was utilized owing to its soft shell and availability in the locality. Baita's (2012) formulation for rice-legume based dehydrated composite mix and Espiritu's (2012) formulation of an instant puffed rice nutrimeal were the essential and initial sources of information as to the materials and methodologies to be adopted in the current study. The studies of Baita and Espiritu both made use of locally-available vegetable material as nutrient enhancer.

Preparation of Adlay

Tapol variety of adlay grains was dried until 12-13% moisture content was obtained. Moisture content is an important consideration in the removal of the hull and for higher recovery of the grits. Dried adlay grains were milled using an industrial rice miller.

Adlay grits was soaked in water for eight hours. It was then pressure-cooked for 15 minutes at 10 psi with a cooking liquid mixture composed of water (80%) and moringa extract (20%) with 1:2 adlay grits: cooking liquid proportion. Pressure-cooked adlay grits were then dehydrated

in a mechanical dehydrator set at 70°C for six hours. The dehydrated adlay-moringa grits were then cooled, grounded, sifted and packed in a plastic container and sealed using a hand-operated plastic sealer.

Other ingredients such as red mungbean and squash were utilized as nutrient enhancers. Non-dairy creamer and coco sugar were also used as sweetener and flavour enhancer, respectively.

Red mungbean was cleaned to remove filth and stones, weighed and washed. Mungbean was added with water in a 1:1.5 proportion and pressure-cooked for five minutes. It was then drained and weighed. Cooked red mungbean was dehydrated for five hours in a drying oven set at 70°C, cooled, ground, sieved, packed and sealed. Squash was added as a nutrient enhancer. Mature stage of Miracle variety of squash was used. After washing with water, the squash was peeled, chipped and steamed for three to five minutes. Steamed squash chips were dried in a drying oven set at 45-55°C for 5-6 hours. Dried squash was collected, cooled and powderized using a mechanical powderizer, sieved and packed in a plastic container until use.

Non-dairy creamer and coco sugar was utilized as the flavor enhancer and sweetener, respectively. The said materials were purchased from Naga City supermarket.

Formulation of Adlay nutrimeal

Table 1 below shows the accepted formulation for Adlay nutrimeal selected from the preliminary formulations and evaluations made. The following formulation was selected as it was most preferred by the evaluators and was found to have acceptable sensory characteristics (color, aroma, taste, flavor, consistency and general acceptability).

Table 1. Formulation of ingredients for instant Adlay Nutrimeal.

Ingredients	Percentage Weight (g)
Dehydrated Adlay-Moringa powder	3.60
Red mungbean powder	3.00
Squash powder	4.50
Coco sugar	10.50
Non-dairy creamer	8.40

Evaluation of Adlay Nutrimeal

Sensory Evaluation

Sensory evaluation was conducted in order to evaluate the color, aroma, taste, flavor and general acceptability of the product (Mabesa, 1986). Each panelist was asked to evaluate the product and indicate their responses using a score sheet.

Pre-evaluation Activities

A week prior to the conduct of the evaluation, necessary permits were secured from the head of the school, parents and guardians of the evaluators from elementary levels. Permits from offices such as letter of request and parent's consent of the pupil-evaluators concerned were obtained as precautionary measures in the identification of food restrictions of the selected pupils.

Selection of Panelists

Four randomly selected groups of panelists were selected from elementary grade level, high school level, partially-trained college students and trained professionals to evaluate the product. Each group was composed of fifteen (15) members and was randomly selected from the populace of the Central Bicol State University of Agriculture- Main Campus, Pili, Camarines Sur. our different groups were randomly selected as panelists.

Elementary Pupils. Evaluators were selected from Grade IV class, composed of 3 boys and 2 girls of 10-12 years of

age. Elementary pupils were gathered and briefed on how the evaluation will be carried out. Instructions on the use of the score sheets for their responses to describe the sensory attributes were given. An interview about their food intake, kind of vegetables, frequency consumption of instant food products, and kind of vegetables being consumed, were noted.

High School Students. High school senior class of age ranging from 16-17 years old and selected randomly, on a voluntary basis, evaluated the product. The fourth-year students were inquired high school students could already identify and declare their food restrictions such as those containing allergens, so that the researcher saw no need for permits from the parents. Evaluators were also assessed as to their intake of commercial instant food mixes and appreciation and consumption of vegetables and food products.

Partially-trained and trained panelist. Third year college students undertaking BS Food Technology and staff of the department of Food Science, CBSUA, Pili, Camarines Sur were considered as partially-trained and trained evaluators of the product. Familiarity and preference of existing instant food product, knowledge and training were considered as criteria for the selection of panelists for the sensory evaluation of adlay nutrimeal. Food and vegetables consumption as well as its frequency of intake were also noted.

Partially-trained panelists were randomly selected. They were identified considering their knowledge on sensory evaluation of similar food products (instant meal or drink). Trained panelists were also selected randomly. They are those who had training and exposure on the practical conduct of sensory evaluation of foods. They are professionals and experts in the field.

A brief orientation prior to the sensory evaluation of adlay nutrimeal was conducted. Instructions on the use of the scoresheet were likewise given. Evaluators' personal information such as name, gender, grade level or position, and age were also noted.

Sensory Evaluation and Attributes

The product was evaluated as to color, aroma, taste (sweetness), and texture (consistency) using nine-point Facial Hedonic rating scale for elementary and high school panelists, while descriptive rating and nine-point Hedonic rating scale was used by partially-trained and trained panelist.

The evaluation was conducted in the sensory room where each group was gathered one at a time to prevent discussion of their perceptions regarding the product. Each evaluator was seated in a testing booth, each with adequate lighting and good ventilation. The booth is partially enclosed to provide maximum independence and privacy to the panelist during the evaluation. Each evaluator was given an ample amount of the sample and a score. Water was also given to cleanse their palate to best evaluate the product's sensory characteristics.

Evaluation of the products' characteristics were determined using score sheets as a nine-point Facial Hedonic scale for elementary and high school pupils. Descriptive rating scale and Nine- point Hedonic Scale were used for partially-trained and trained evaluators. The nine-point Facial Hedonic scale for elementary and high school evaluators was used to detect individual preference and evaluation of the product (Brown, 2005). This type of affective test is easier to understand by the group.

Statistical Analysis

Data were gathered and subjected to Analysis of Variance (ANOVA). The mean are separated using Tukey-Kramer Test at

95% confidence level.

Preparation and Testing method for Instant Adlay Nutrimeal

The adlay-veggie nutrimeal (55g) was mixed in 275ml hot water and stirred. Each panelist was given 80 ml of the prepared instant adlay nutrimeal in a clear, coded glass.

Two sets of score sheets were prepared to determine the level of acceptance of the product among the different groups of evaluators. Facial hedonic scale was used for the elementary pupil evaluators, while attribute rating scale and nine-point Hedonic scale were used for the partially-trained and trained panelists. The scales used to quantify the sensory attributes and level of acceptability of the product. Results were calculated using weighted mean scores which were descriptively rated.

Physico-chemical Properties of Adlay Nutrimeal

Formulated instant adlay nutrimeal was subjected to physico-chemical analysis. These rehydration characteristics and chemical tests include pH, total soluble solids (TSS), viscosity, moisture content, and water activity (a_w).

Rehydration Characteristics

A series of tests was conducted to determine the rehydration characteristics of the mixture formulated. Test was particularly done to evaluate the solubility, sinkability, dispersability, and flowability of the product at different temperatures. The test was conducted for reliability of the results.

Physico-chemical Tests

This test includes the determination of pH, total soluble solids (TSS), moisture content and water activity (a_w) of the product. Results were read thrice for accuracy.

Microbial Test

Samples were also subjected to microbial analysis to determine the presence of microorganisms in the product. Total plate and yeast and molds count was determined using Plate Count Agar and Potato Dextrose Agar, respectively. Sample was diluted up to 10-3 and plated in triplicate. Incubation was done for two days for total plate count and three to five days for yeast and molds count, respectively. Results were computed and expressed as log colony forming units per gram (log CFU/g).

Proximate Test

Formulated adlay-veggie nutrimeal was subjected to proximate analyses. The crude fat, protein, fiber, ash and moisture content of the product were determined through standard methods (Nielsen, 1994). This test is required for the determination of the nutritional content of the food sample. Product was sent to the Department of Science and Technology-Regional Office V, Rawis, Legazpi City for the analysis.

Nutritional Composition

Nutritional composition of the product was determined by computation using the data from the proximate test made. The nutritional computation is based on 55g content of the product. Gathered results were indicated on the label of the instant adlay nutrimeal. Computation of the carbohydrates content of the product was done through calculation by difference method (Food Composition Table, FNRI, 1999).

RESULTS AND DISCUSSION

Formulation of Adlay Nutrimeal

Baita's (2012) formulation was initially considered as to the proportion of ingredients. Modifications on the proportions and preparation of the ingredients were made to improve texture and to suit the purpose for which the intended product will be consumed. Product trials on the formulations and processing were conducted to establish the most accepted proportion of the ingredients. Each formulation was evaluated and improved on various

aspects so as to make it consumable by the intended consumers. The most acceptable formulation for instant Adlay Nutrimeal is presented in Table 2.

Table 2. Accepted Formulation for Instant Adlay Nutrimeal for 55g content.

Ingredient	Percentage
Dehydrated Adlay-moringa powder	12
Red mungbean powder	10
Squash powder	15
Coco sugar	35
Non-dairy creamer	28

Among the preliminary formulations, the evaluators' preference as to the taste, texture and consistency was that of formulation in Table 2. It was selected as the final formulation and was subjected to various standards and important tests for its acceptability among prospective consumers. As seen in Table 2, the identified best formulation of instant nutrimeal was calculated and formulated. The formulation was in line with the 55g -content requirements as standard for instant food mixes set by the Department of Science and Technology.

Processing of Instant Adlay Nutrimeal

The choice of ingredients was greatly determined by two major objectives such as to produce a product with high nutritional value and with good sensory characteristics (Aslanova et al., 2021). Both objectives could be achieved with the use of the following ingredients; adlay-moringa powder (12%), squash powder (15%), coco sugar (35%), red mungbean powder (10%) and non-dairy creamer (28%). It likewise, was noted to be the best formulation as identified by respondents.

Adlay (*Coix lacryma jobi*-L var. *Tapol*) grains were sun-dried to attain 12-13% moisture content and milled using a rice miller to remove the seed coat or hull. Adlay grits were gathered after milling and were packed in a plastic bag for later use.

Adlay grits were cleaned by removing the stones, unmilled adlay grains and large bran. It was then soaked in water for eight hours, drained and pressure-cooked using 1:2 proportions (adlay: cooking liquid). An 80:20 water–moringa extract was used as cooking liquid. Adlay cooked with moringa extract did not cause and produce an appreciable moringa taste.

Two kilograms of cooked adlay-moringa mixture was spread in a baking sheet, and placed in the mechanical dehydrator set at 70°C for six hours. It yielded 750 g of dehydrated adlay-moringa. The dehydrated mixture was then ground using an industrial grinder. The yield after grinding was 700g powder, it was then packed and sealed in plastic for future use.

The use of low temperature at 45-55 °C and high at 70°C as drying temperatures for red mungbean, squash and adlay-moringa promote the retention of the heat-sensitive nutrients in the materials. This temperature is not detrimental to tissues and does not cause the degradation of nutrients (Fennema, 1996). The process also removes moisture and improves flavor (Paz, 2012), thus, adopted in the process.

The percent recovery of each ingredient was determined with red mungbean having the highest recovery after dehydration followed by adlay at 35.71%. High recovery was observed owing to the fact that the material does not contain high amounts of moisture as it naturally comes in dry form (Capule & Trinidad, 2016).

Squash yielded 11.19% recovery since it contains a high amount of moisture. Drying of squash results in high moisture

loss. In drying, heat is used to remove water from the foods, thus food is preserved by avoiding microbial growth and deteriorative reactions (Shaman, MS & Perera, 2010).

Water has a significant impact on quality attributes, shelf stability, textural properties and processing (Levine and Slade, 1991). Fresh produce is fresh and perishable because of its moisture content. However, to preserve quality and prolong stability, the moisture content of the food must be reduced. Drying is one such practical method of moisture removal.

All dehydrated powders were sieved after grinding to produce a uniform particle size for nutrimeal preparation. It was then packed and sealed for future use. Coco sugar was utilized to make the product natural and healthy. As cited by Baita (2012), this sweetener has low glycemic index at 35 and has high mineral content as compared to other sweeteners. Coco sugar is totally natural and therefore free from additives and artificial flavourings (DOST-FNRI). In addition, coconut sugar also contained higher concentration of fructose and glucose with lower concentration of sucrose compared with those of sugar palm and sugarcane juices. Hence, these properties showed that it could be served as a potential healthier sugar source compared with sugar palm and sugarcane juices (Asghar et al., 2019).

During processing, the application of high temperature and extended processing time would result in the browning reaction of coconut sugar (Yanto et al., 2018). The amount of heat susceptible vitamins like vitamin C and B3 were also decreased during prolonged heating which degraded the quality of coconut sugar (Kolawole et al., 2013; Yusof et al., 2020). In this study, the quality and properties of coconut sugar was maintained by applying proper methods during rehydration.

A commercial brand of non-dairy creamer was used to increase the protein content of the product. It also adds to the consumer appeal through the improvement of taste and texture by making it creamy and smooth.

Adlay nutrimeal was mixed thoroughly and was packaged in a pre-formed laminated bag and sealed using a foot sealer. Each pack contains 55g of dehydrated adlay-vegetables mixture as based on the standard for instant food mixes set by the Department of Science and Technology.

Evaluation of Adlay Nutrimeal

Sensory Evaluation

This test was done to determine the product's attributes and quality. Daget (1977; PTTC, 1993) notes that if sensory evaluation is to be used as a tool for valid reliable measurement of specific product attributes or characteristics, adequate control of test conditions must be observed. This includes physical and environmental conditions, techniques in sample preparation and presentation and selection, training and calibration of panelists. This is done to reduce sources of variation which may affect responses of the evaluators (Gatchalian, 2011).

Selection and Pre-evaluation by Panelists

Four different groups were randomly selected as panelists for the evaluation of the product. Permits from offices such as letter of request and parent's consent of the pupil-evaluators concerned were obtained as precautionary measures in the identification of food restrictions of the selected pupils.

Elementary pupils. It was noted that elementary pupil-evaluators prefer kangkong, carrots, white potato, and sayote as vegetable additives to their meals. Evaluators consume less of instant food products such as powdered cereal mixes and drinks.

High school students. The female respondents were noted to be more familiar with the instant food products as compared to males. Interestingly, males consume more commercial instant food products than females. Generally, consumption of vegetables is high with this group and variety of vegetables is preferred.

Partially-trained and trained panelist. The group of partially-trained panelists was mostly female at 19-23 years old. The trained panelists were mostly female with age 22-45 years old. The groups are proficient in the evaluation of food products, particularly the trained ones. Research and development of food product and its evaluation are part of their employment as professional instructors. Some had trainings on evaluating food products. Thus, confidence could be had on the outcome of the evaluation.

Sensory Evaluation and Attributes

Elementary pupils

From the results of the sensory evaluation made by the elementary pupils, the product's sensory characteristics were rated as liked moderately as to color, aroma, and taste, while liked very much for its texture. Table 3 shows the summary of the evaluation of the adlay nutrimeal among elementary pupils.

Color. The color of the product was rated 7.4 and described as liked moderately by the group. The adlay nutrimeal was pale brown to off-white in color which was affected by the dehydrated vegetable powders used in the formulation. In addition, the coco sugar had light color (L value) with low browning index, which would be beneficial for its utilization in food production (Asghar et al., 2019).

Elementary pupils are very particular with the physical appearance and color of food products. The product was liked moderately mainly because the evaluators associated the color to beverages such as mocha, chocolate with milk or coffee with milk.

Aroma. The aroma of the product was rated 7.0 and was described as liked moderately by the evaluators. This was affected by the vegetable powders and other ingredients utilized in the product. The pupils of young age at that we're choosy on vegetable intake. From the responses gathered, kangkong, carrots, white potato and sayote are among their favourite vegetables. None of which were used as ingredients for the formulation of the product.

Taste (sweetness). As perceived by the evaluators, the product was rated 7.0 and described as liked moderately. The sweetness of the product was perceived by the pupils and was liked moderately. This is brought about by the use of coco sugar which is also unfamiliar to their taste buds.

Table 3. Elementary and High school panelists sensory characteristics of instant Adlay-veggie nutrimeal.

Attributes	Elementary		High School	
	Weighted mean	Descriptive rating	Weighted mean	Descriptive rating
Color	7.4	Like moderately	7.8	Like very much
Aroma	7.0	Like moderately	7.4	Like moderately
Taste	7.0	Like moderately	7.8	Like very much
Texture	7.8	Like very much	8.0	Like very much

They also consumed less of the ingredients used in the product. The ingredients of the mixture were not that familiar to them and vegetables are not well-appreciated.

Texture (consistency). The product was rated 7.8 and described as liked very much; this was perhaps due to the particles of the ingredients utilized which did not dissolve easily. The product has viscous consistency which appealed to the senses of the evaluators.

High school Level

Results of the evaluation made by the high school students revealed that the nutrimeal's color, taste and texture were described as liked very much while the aroma was liked moderately.

Color. The color of the product was rated 7.8 and described as liked very much. The acquaintance of the evaluators with the reference product (cereal drink) may have led to the high appreciation and acceptability of the color of the product.

Aroma. The aroma of the product was rated 7.4 and was described as liked moderately by the evaluators. This denotes that the group are familiar with the vegetables and other ingredients which may have been the reason for their appreciation of the aroma of the formulated nutrimeal.

Taste. The formulated nutrimeal's taste was rated 7.8 and described as liked very much by the group. With the knowledge and acquaintance of plant-based food items they appreciate the taste of the product. The sweetness of the coco sugar combined with non-dairy creamer and other ingredients in the formulation passed the threshold level for sweetness of the high school students.

Texture (consistency). The adlay nutrimeal was rated 8.0 and described as liked very much as shown by the sensory evaluation. This could have been due to the fineness and viscosity of the product as a cereal drink.

Results of the evaluation made by the partially-trained and trained panelists with regard to the sensory attributes for color, aroma, taste (sweetness) texture (consistency), and flavor (adlay-vegetables) were summarized in Table 4.

Based on the result, ANOVA revealed that there is no significant difference ($p<0.05$) between the ratings of the two groups of evaluators.

Partially-trained panelist

Based on the results, the product was described as having light brown color, desirable aroma, sweet taste, moderately viscous consistency and perceptible adlay-vegetable flavor.

Color. The color of the product was rated as 3.4 mean score and described as light brown. Color was influenced by the addition of dehydrated adlay powder, mungbean and with the addition of non-dairy creamer.

Aroma. The aroma of the product was rated 3.6 and described as desirable. This would show that the group appreciates the mixture of aroma of vegetables and other ingredients in the product. The pleasant aroma of red mungbean and non-dairy creamer influences the desirable aroma of the adlay nutrimeal.

Taste (sweetness). The formulated nutrimeal's taste was rated 3.8 and described as sweet. The sweetness of the coco sugar combined with non-dairy creamer and squash in the formulation passed the level of sweetness of the panelist and was rated as perceptible.

Consistency. Adlay nutrimeal's consistency was rated 3.4 and described as moderately viscous as revealed by the sensory evaluation test. This is influenced by the characteristic of the adlay which is slightly glutinous and the vegetable powders added such as red mungbean and squash that contributes to the viscous texture of the

Table 4. Partially-trained and trained panelists' sensory characteristics of instant Adlay-veggie nutrimeal.

Attributes	Partially-trained		Trained	
	Weighted Mean	Descriptive rating	Weighted mean	Descriptive rating
Color	3.4	Light brown	3.0	Light brown
Aroma	3.6	Desirable	3.6	Desirable
Taste (sweetness)	3.8	Sweet	3.8	Sweet
Consistency	3.4	Moderately Viscous	4.0	Viscous
Flavor (adlay-vegetable)	4.0	Perceptible	4.0	Perceptible

nutrimeal or drink.

Raw material consistency could be an index for determination of the necessary amounts of other ingredients to attain the desired finished product's consistency. (PTTC, 1993) The ingredients used in the formulation were processed and prepared to get the desired consistency which is moderately viscous. The product is to be consumed as a drink.

Flavor (adlay-vegetable). The product was rated as 4.0 which was described as perceptible adlay-vegetable flavor. Evaluation revealed that the product was prepared using the optimum proportion for each ingredient utilized in the formulation. Combination of the different flavors of the ingredients contributed to the total flavor of adlay nutrimeal.

Trained Panelist

The responses of the trained evaluators (professionals), the sensory attributes for color, aroma, taste (sweetness) texture (consistency), and flavor (adlay-vegetable) are rated, described and summarized in Table 4.

The product was described as having light brown color, desirable aroma, sweet taste, viscous consistency, and perceptible adlay-vegetable flavor.

Color. The color of the product was rated 3.0 and described as light brown. This was affected by the use of non-dairy creamer and dehydrated adlay powder which balances with the color of red mungbean powder. The evaluators are familiar with the reference product or the commercially available cereal drink. The evaluators conclude that the nutrimeal has the likeness with the reference product as to color.

Aroma. The aroma of the product was rated 3.6 and was described as desirable. Desirability was influenced by the mixture of the powdered ingredients which compliments with the distinct aroma. This denotes that the group are familiar with the aroma of vegetables and other ingredients used in the nutrimeal.

Taste (sweetness). The formulated nutrimeal taste (sweetness) was rated 3.8 and described as sweet. The sweetness of the coco sugar as combined with non-dairy creamer as well as the other ingredients in the formulation passed the criteria of evaluation according to the perception of the trained panelist.

Individuals vary greatly as to the level of threshold concentration. Several factors are responsible for this variation. Threshold concentration for sugar is greater than for

salt. The relationship of temperature of a solution to be tasted and taste sensitivity differs for various substances (Hahn,1936). A sweetener threshold decreases from 17°C to 34°C then increases slightly to 42°C. This is why the group of panelists had different perceptions on the taste (sweetness) of the product.

Consistency. Adlay nutrimeal consistency was rated 4.0 and described as viscous. Viscous texture of the product was influenced by the Tapol variety of adlay used, which is glutinous and the vegetable powders added such as red mungbean and squash that can be rehydrated and are water-soluble.

Desired consistency or viscosity of finished product may be obtained through proper balance of the ingredients utilized in the formulation. Since consistency of the product is influenced by the temperature and extent of agitation of mixture, such changes could provide indications of the extent of disaggregation or depolymerisation of protein, starch and pectin (Kramer and Twigg, 1973).

Flavor (adlay-vegetable). The product was rated 4.0 and described as having perceptible adlay-vegetable flavor. The natural flavor of adlay and vegetables were perceived by the evaluators which means that the pre-treaments such as steaming, pressure-cooking and dehydration employed in the preparation of the powders as used in the formulation was not affected by the processes involved.

Dehydrated cooked food more closely resembles the cooked food in flavor, odor and other sensory attributes when dehydrated or dried in proper time and temperature (cited by Baita, 2012; Anon, 1983; Maltini etal,1993). The use of low heat temperature, as 45-70°C on dehydration does not alter the flavor of the different ingredients utilized.

Acceptability

Acceptability of the product is affected by the different sensory attributes evaluated. Table 5 summarizes the acceptability of the instant adlay nutrimeal among the different groups of panelists.

The foregoing table reveals that there was no significant difference at 5% level of significance in the product's acceptability based on the ratings given by the four groups of evaluators.

It was rated 7.4 to 8.0 which is described as liked moderately to liked very much by the different groups of evaluators. The elementary pupils' rating as liked moderately may have been due to the fact that they are not used to the consumption of the ingredients specially the dehydrated vegetable.

While high acceptability of the product among the three groups of panelists may be attributed to their familiarity with the ingredients used and the value and quality

Table 5. Acceptability of instant Adlay-veggie nutrimeal.

Evaluator	Weighted mean score	Descriptive rating
Elementary pupils	7.4	Like moderately
High school students	8.2	Like very much
Partially-trained panelist	7.6	Like very much
Trained panelist	8.0	Like very much

of the reference product. The ingredients used were mixed in best proportion which contributed to the acceptability of the product developed.

The frequent consumption of the ingredients such as moringa, squash and mungbean renders familiarity on the taste and flavour of the product. This contributes to the high acceptance of the combination of these vegetables to the formulated instant cereal-vegetable drink. Conversely, the majority of panelist gave the product a high acceptability rate which implied that there is a potential market for Adlay-veggie nutrimeal.

Physico-chemical Test

Standard procedures as recommended by Al-Kahtani, Hassan (1990), Niro (1978) and Nielsen (1998) for rehydration characteristics for chemical analyses were followed in this study.

Physical Properties

Rehydration behaviour of adlay nutrimeal was determined at different temperature conditions as 50, 70, and 90 °C for its sinkability, dispersability and solubility. The flowability of the product was also determined. According to Karel (1975) as cited by Baita (2012), ideal powders are those that disperse rapidly and completely in water. These types of powders have a large wettable surface and resistance to sedimentation.

Solubility. Solubility of the sample was determined at different temperature ranges (30, 50, 70, and 90 °C). Ten grams of samples were added to 100 ml hot distilled water. The sample was stirred and the time was noted until the powder had dissolved completely. Good solubility would mean that the sample dissolves in one minute or less.

Sinkability. Sinkability of the sample was determined at different temperatures (30, 50, 70, and 90 °C). Ten grams of sample was placed in a funnel with a pestle blocking its opening. Pestle was lifted and time was noted until the sample sunk into the bottom of the beaker. Presence of lumps or dispersion of the powder at the bottom of the beaker was noted.

One to two seconds sinking time is rated as having good sinkability; two to ten seconds has fair sinkability; and more than ten seconds is rated as having poor sinkability.

Dispersibility. Dispersibility of the sample was likewise determined at different temperature ranges (30, 50, 70, and 90 °C). One hundred millilitres (100 ml) of distilled water was placed in a beaker to which ten grams of sample was poured. Twenty-five (25) circular movements within 15 seconds were made while observing time of dispersion using a stopwatch.

Sample was characterized as having many lumps, few lumps or well-dispersed. Sample where many lumps were observed was rated as fair and those that are well-dispersed were rated as good. Table 6 presents the results of the dispersibility test at different temperature ranges.

Flowability. The flowability characteristic of the sample was observed using 55g of sample poured in a large stemmed. The sample powder which drained rapidly from the funnel was rated as having good flowability. The sample which bridged to some extent or was slow but still drained from the funnel was rated as fair. Poor flowability was noted as a sample which did not completely drain from the funnel unassisted.

Results for rehydration characteristics of adlay nutrimeal are summarized in Table 6. It may be noted that the nutrimeal has good sinkability, dispensability and solubility at 70-90 °C, whereas fair to poor rehydration at lower temperatures of 30-50°C. Flowability of the product was rated fair notwithstanding it completely drained from the funnel. The

rehydration characteristics of the product ideally conform with powder mixes.

Table 6. Rehydration characteristics of Adlay-Veggie nutrimeal at different temperatures.

Rehydration Characteristics	Temperature (°C)			
	30	50	70	90
Sinkability	Poor	Poor	Good	Good
Dispersability	Poor	Fair	Good	Good
Solubility	Poor	Fair	Good	Good

Legend: **Poor**- many lumps; **Fair**- few lumps; **Good**- well- dispersed

Chemical properties

Adlay nutrimeal was subjected to chemical analysis such as pH, total soluble solid, and moisture content. Table 7 shows the result of analyses in these aspects.

Table 7. Physico-chemical characteristics of Instant Adlay-Veggie Nutrimeal.

Parameter	Result
pH	6.5
Total soluble solids	15°Bx
Moisture content	5.25%
Water activity (a_w)	0.481

pH determination

A pH meter was used to determine the pH level of the sample. Results showed that the product is a near neutral food product with 6.5 pH value. Frazier and Westhoff (1988) as cited by Baita (2012) and Ignao (2013) suggest that high pH value would lessen the likelihood of microbial growth, while the lower pH value contained will slow down microorganisms.

Total Soluble Solids (TSS)

Refractometer was used to determine the total soluble solids (TSS) of the sample. The recorded brix value which is an indicator of total soluble solid content was 15°Bx.The low amount of soluble solids of the product connotes that the product has low amount of sugar and is significant in the rehydration for instant food products.

Moisture Content

A mechanical drier was used in the determination of moisture content. Moisture content of the product is within the recommended value for complementary foods of (5-10%) with 5.25 to 7.21% which translates to the stability of the product. According to Badamos et al. (1996) the moisture content of food is an important index of their susceptibility to microbial spoilage. Relatively low moisture content would therefore indicate low growth of bacteria and fungi. Therefore, one of the important determinants of shelf stability of foods (Gbenyi, 2014).

Water activity (a_w)

This test was done to determine the amount of available water in the product for microbial growth using a water activity meter. Sample was sent to the Department of Science and Technology-Legazpi City for analysis.

The low value for water activity of the product at 0.481 means that no microbial proliferation is possible to occur. According to Bell et. al (2005) cereals should have a minimum of 0.700 aw to be considered free from xerophilic fungi while lower than 0.600 aw so that no microbial growth is possible.

Microbial Analysis

Results show that the microbial count of the product contains <10 log CFU/g for total plate while 2.78 log CFU/g for yeasts and molds. Since the product is in dehydrated form, bacteria cannot survive or can hardly grow on a <5 count or no growth when incubated. The very low moisture content at 5.45% as determined by moisture determination and 7.21% from the proximate test supports the results obtained. This is also sustained by the result of the water activity of the product at 0.481a_w.

According to Shitata et al. (1983), dried powder is almost microbial-free. Water activity determines perishability of the food product (Brown, 2005). Dry product has low aw thus, lower growth rate of microorganisms and stability of the product is prolonged (Ignao 2013; Baita, 2012).The application of various heat processes such as steaming, boiling, pressure-cooking and dehydrating prevents and reduces microbial load in food products. Most organisms, especially microbial pathogens, stop growing at temperatures above approximately 50°C (Bell et al., 2005).

Both counts for total microbial and yeast and molds of the product revealed that the product has low count and passed the standard set by the Philippine National Standards for dehydrated powders like breakfast, cereal and snacks foods. Results showed that the product has stability against microbial degradation thus, can be produced in bulk, commercialized and stored for longer periods when packaged properly.

Proximate Test

Proximate test was conducted at the Department of Science and Technology (DOST), Legaspi City. The nutritional composition of the instant adlay nutrimeal was determined per 55g serving, the standard net content set by the DOST for the product.

The results of the proximate test conducted by the Department of Science and Technology, Legaspi City are summarized in Table 8.

Table 8. Results of Proximate tests for Instant Adlay-veggie nutrimeal.

Parameter	Result (%)
Ash	2.21
Fat	11.88
Protein	6.33
Crude fiber	1.93
Moisture	7.21

Total carbohydrate is determined by difference method which resulted to 72.38%. Using calculation by difference, the amount of total carbohydrate in a food product is done by 100%- (%moisture+%protein+%fat or lipid+% ash).

Calculation implied that adlay nutrimeal contains a remarkably high amount of carbohydrates which further suggests that adlay is a good substitute for other energy-rich crops and plants for food preparation.

Nutritional Composition

Adlay-veggie nutrimeal contains essential and the most required nutrients needed by an individual. The nutrimeal contains a high amount of carbohydrates with 230 calories per serving which comprises 40g carbohydrates, 7g total fats and 3g protein. The product is a good source of energy because of the carbohydrates. Overall, it is superior in carbohydrates and protein as compared with the two leading cereals in the market.

Carbohydrates form the basis of the energy cycle. This comes in many forms such as saccharides which may be monosaccharide, oligosaccharides, polysaccharides, and derivatives from carbohydrates. Sources such as cereal grains, sugars, fruits and starchy vegetables contribute to the carbohydrates content of the food product. Carbohydrates in food functions as cheap and main energy food, protein sparer, regulator of fat metabolism, and regulator of intestinal peristalsis and provider of bulk for individual requirement. (Claudio, 2004).

The formulated instant adlay nutrimeal contains high amounts of carbohydrates owing to its ingredients as adlay, mungbean and squash powder. The use of coco sugar as sweetener also contributes to the carbohydrate content of the product. These factors ensured not only high nutritional value but contributed to its good sensory characteristics of the product as well.

Protein is essential in humans with its functionality as a structural role, a fuel nutrient and regulatory of physiologic processes (Claudio, 2002). Protein can be sourced from protein-containing food items such as meat and legumes. In plants, protein is prominent in legumes and seeds, nuts and cereal and cereal products.

CONCLUSIONS

The processing of adlay grits into instant nutrimeal comprises simple and easy procedures. Adlay grains were soaked overnight then cooked with water-moringa as cooking liquid through pressure-cooking at 15 psi for 10 minutes. The adlay grits were further dehydrated in a mechanical dehydrator at 70°C for six hours. Dehydrated grits were ground using an industrial grinder, sieved and mixed with other vegetable powders such as red mungbean and squash. Coco sugar and non-dairy creamer was added to enhance the taste and flavor of the nutrimeal. An acceptable formulation was established for the development of the instant adlay nutrimeal.

Sensory evaluation of four groups of panelists shows the general acceptability of the product, which was described as liked very much by three groups as high school, partially-trained and trained panelists. The elementary panelists liked the product moderately. Through descriptive tests, the product's sensory attributes were described as light brown in color, with desirable aroma, moderate to sweet taste, moderately viscous to viscous consistency, and perceptible adlay-vegetable flavour. Since the product was remarkably accepted by the panelist which implied its possible market potential.

Results of the physico-chemical tests of the product manifest that pre-treatments and processing of the ingredients does not affect the properties of the product. Adlay nutrimeal had pH value of 6.5, 15°Bx total soluble solids and 5.25% to 7.21% moisture content. These properties are essential in the stability of the product against physical and chemical changes in foods, and microbial degradation as may be affected by storage quality and time. The use of pre-treatments to ingredients such as steaming, cooking, pressure-cooking and grinding do not have drastic effects on the natural properties of the ingredients moreso, it improves its stability.

Physical properties of the product were determined using rehydration characteristics which is an important attribute of instant food mixes. These rehydration characteristics include sinkability, dispersibility, and solubility at different temperatures as 30, 50,70, and 90°C. Flowability was also noted. Results showed that adlay nutrimeal has poor sinkability, dispersibility and solubility at 30°C while poor to fair at 50°C. At temperature range of 70-90°C, the product has good rehydration characteristics. Results further shows that the nutrimeal has good flowability which is an important parameter which affects the acceptability of the product.

Results on microbial counts for total plate on yeasts and molds of adlay nutrimeal revealed that the product has low microbial growth. The low counts were influenced by the dehydration of the product and its low water activity.

Results of a proximate test showed that 100g of the product contains 7.21% moisture content, 2.21% ash, 11.88% fat, 6.33% protein, 1.93% crude fiber and 0.481% water activity. Carbohydrate content was noted high at 72.37%.

Nutritional computation revealed that the product packed in 55g contains 230 calories, from 40g carbohydrates, 7g fats, 3g protein and 5g of other essential food components such as fibers, vitamins, and minerals. In addition, the product is a high-energy food product and contains essential nutrients for an individual's daily dietary requirements.

The pre-treatments and processing employed in the processing of adlay nutrimeal notably do not affect the sensory properties of the product. Most importantly, the essential and heat-sensitive nutrients were not affected by the time and temperature range applied in the dehydration process

Moreover, the formulated adlay nutrimeal was likewise evaluated alongside three existing commercial instant products. The results showed high acceptance, hence, shows the potential of adlay nutrimeal to be a competitive addition to the array of instant food products in the market. Overall, the study findings provide evidence of the compelling potential of adlay to be utilized as a new alternative food source and profitable crop in food production.

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