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Processed snack foods: Their vitamin and mineral composition and percentage contribution to the recommended nutrient intakes (RNI) of school children

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Abstract

Proper nutrition is important as children grow, and snack time should be just as healthy and delicious as breakfast, lunch and dinner. The study aimed to evaluate the vitamin and mineral composition of four processed snack foods and to analyze the % RNI contributed by these foods to the daily needs of school children. Moreover, the researchers attempted to identify the most concentrated sources of vitamin B1, vitamin B2, Vitamin B3, vitamin B9, calcium, and iron among the snack items. Results showed that of the six vitamins evaluated, vitamin A is the only vitamin supplied in ADEQUATE amounts by the four snack items namely Jute-Malabar Nigthshade Pastillas, Banana Blossom Cookies, Malunggay Polvoron, Squash-Carrot Pastiyema. In terms of the minerals, calcium and iron, only Malunggay Polvoron met at least 20% of the RNI for these nutrients for both age groups 4-6 and 7-9 years old. All the four snack items supply at least 20% of the RNI for vitamin A and riboflavin for the two age groups. On the other hand, the snack item with the most dense nutrients is Malunggay Polvoron. Sensorial qualities to include quality characteristics, consumer acceptance as well as their packaging may be conducted. Furthermore, the development of other nutrient-dense snack items with emphasis on the incorporation of leafy and fiber-rich vegetables is encouraged.

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Introduction

Proper nutrition is important to growing children. To complete their day's nutritional needs, at least six small meals must be provided and snack time should be just as healthy and delicious as breakfast, lunch and dinner. This small frequent meal is essential for children because their smaller stomachs fill up fast and they burn calories quickly. Inasmuch as snack time accounts for about 10-15% of kids' daily calories, each snack food should contribute to their total calorie and nutrient requirements.

The study aimed to evaluate the vitamin and mineral composition of four processed snack foods and to analyze the% RNI contributed by these foods to the daily needs of school children. Moreover, the researchers attempted to identify the most concentrated sources of vitamin B1, vitamin B2, Vitamin B3, vitamin B9, calcium, and iron among the snack items. The conduct of this study will benefit not only the farmers but more importantly, the consumers, specially the children who shall be provided with additional options for healthier snack foods enriched with vegetables.

According to the 2010 Dietary Guidelines for Americans Report, a processed food is "Any food other than a raw agricultural commodity… that has been subjected to washing, cleaning, milling, cutting, chopping, heating, pasteurizing, blanching, cooking, canning, freezing, drying, dehydrating, mixing, packaging, or other procedures that alter the food from its natural state (USDA,2010). This definition implies that almost all foods we eat, including snack foods, have been processed.

It may not always be obvious which foods are processed, however both fresh and processed foods make up vital parts of the school canteens and the grocery shelves.

Processing also may include the addition of other ingredients to the food, such as preservatives, flavors, nutrients, and other food additives or substances accepted for use in food products, such as salt, sugars, and fats (USDA, 2010)."

Processed food contributes to both food security (ensuring that sufficient food is available) and nutrition security (ensuring that food quality meets human nutrient needs) (Weaver, 2014).

There is a common misconception that processed foods in general are "less healthy" or less nutritious as compared to other foods. When we think of "processed foods" we automatically think of junk foods such as Twinkies, Gummy Bears, and Cheetos's, however the reality is many processed foods can offer equal, or in some more rare cases greater nutritive value. For example, your body absorbs more of the "antioxidant" lycopene from stewed canned tomatoes vs. regular whole tomatoes. Processing makes it possible for us to add many important nutrients that many American's would otherwise find it hard to obtain, in sufficient amounts to the diet. In the early 1990's as a result of the addition of folate to grains, a dramatic decrease in neural tube defects among newborn infants was seen. In fact, processed foods contribute approximately 55% of the U.S. intake of dietary fiber, 48% of calcium, 43% of potassium, 34% of vitamin D, 64% of iron, 65% of folate, and 46% of vitamin B-12 (Fulgoni, 2011).

Healthy snacks are important parts of helping children develop healthy eating habits and a regular eating schedule. Many nutritionists recommend eating five small meals a day rather than three large ones. Well-portioned snacks between meals can help children make a habit of grazing throughout the day, and encouraging nutritious snacks will allow them to develop a healthy relationship with food. They will also learn, at an early age, that healthy food can be tasty food, building a foundation for healthy eating habits as they grow.

Many children dislike vegetables in their natural form. This is the opportunity to include these vegetables in their blind manner and in the form they enjoy. In addition, these vegetables contain an array of vitamins and minerals, as well as fiber, which are important for growing children. Moreover, the inclusion of these vegetables forms value adding purposes.

Review of literature

Benefits of Healthy Snacking

Healthy snacks are essential for the physiological development of children. Childhood is a critical time for growth and development, and snacks provide important nutrients that children need between meals. This means children should have a nutrient-dense midmorning and mid afternoon snack at school to meet the nutrient demands of their growing bodies and brains.

The kind and amount of food consumed is very important, hence, portion control is one vital component of healthy snacking. Younger children require less calories and nutrients. Having pre-portioned snacks on hand can be perfect for times when parents and children are on the go.

In the Philippines, a large percentage of the population suffers from one or more forms of malnutrition including micronutrient deficiencies (Rohner, 2013). Among Filipino children, the four major deficiency disorders are protein-energy malnutrition, iodine deficiency disorder, vitamin A deficiency and iron deficiency (Kreissl, 2009). Iron deficiency (manifested as iron deficiency anemia) is the most common form of malnutrition in the Filipino population, especially in children (Rohner, 2013, Hunt, 2002). Despite its importance in the etiology of so many disorders, iron deficiency anemia has not received the necessary attention in many public health spheres (Hunt, 2002). This is thought to be due to several factors. First, the relatively subtle effects of anemia are less apparent compared to the dramatic effects of vitamin A (night blindness and xerophthalmia) or iodine deficiency (goiter and cretinism), resulting in the misconception that anemia is a consequence of other disease processes rather than a primary target for intervention (McLean, 1993). Second, another misperception is that iron deficiency anemia should be addressed therapeutically by the medical profession (such as through prescriptions for iron supplements), rather than through preventive strategies that can be influenced through population awareness and public policy (Cavalli-Sforza, 2005).

Kids love to snack, and fortunately eating between meals is important to a child's growth and nutrition. Children are growing and developing rapidly. Active kids have an increased need for energy as well as other essential nutrients, but they have small stomachs. They need to eat adequate calories but can't eat large amounts at a time. Eating meals and snacks through the day helps children g*et al*l of the nutrients they need.

According to Nielsen Company Survey, the nowadays picture in Spain is that 45% of consumers regularly eat a snack as an alternative to one or more meals daily. Out of this value, 52% do it for breakfast, 43% on lunch time and 40% at dinner moment.

Everybody is aware that it is important to eat a healthy, balanced diet. But, in today's busy, technological world, chances are we could hardly have time to prepare snacks for our children. Parents give them money to buy snacks. Lucky are the children looking for tasty snacks that are loaded with nutrients.

The Hartman Group's "The Future of Snacking 2016" report found that 91% of consumers snack multiple times throughout the day and that, "snacking now accounts for half of all eating occasions as America's consumers say that snacking is essential to daily nutrition."

Following are some reminders when taking packaged snack foods:

1. Always check the label.
2. Look for clean, sanitarily prepared foods, listing ingredients you can recognize.
3. Know your body. Do you have some allergies to ingredients? Are there foods you should limit or avoid? A touch of mindfulness and control before, during, and after meals can often help us to identify foods that work and foods that we would feel better without.

Everybody's diets today incorporate a wide array of minimally to heavily processed foods that contribute to the total daily intake of nutrients and other dietary components. The 2012 Dietary Guidelines for

Filipinos s provide recommendations for a healthful diet. Emphasized in the nutritional guidelines are the following:

- Eat a variety of foods every day to get the nutrients needed by the body.
- Eat more vegetables and fruits to get the essential vitamins, minerals, and fiber for regulation of body processes.
- Consume milk, milk products, and other calcium-rich food such as small fish and shellfish, every day for healthy bones and teeth.
- Limit intake of salty, fried, fatty, and sugar-rich foods to prevent cardiovascular diseases.

Inasmuch as consumers are now more conscious in choosing the kind of food they eat, processed food products are unavoidable as people also have to balance their eating habits while catching up with their busy schedules. These easy-to-cook and ready-to-eat products, although less nutritious compared to fresh and green choices, on the other hand provide convenience.

Vitamins

Most parents know that children need vitamins and minerals to stay healthy. But knowing exactly what nutrients and how much they need of each is not always easy. Learning a bit more about vitamins and minerals can help ensure your kids are on the right nutritional track.

Despite parents' best efforts, kids may not always get all the vitamins and minerals they need. To make sure your kids are getting the full range of nutrients that they need, be sure to offer your children a variety of foods. Start by taking a closer look at the foods your kids eat on a regular basis.

Vitamin A

Vitamin A is important for healthy skin and normal growth, and it also helps vision and tissue repair. Vitamin A can be found in rich quantities in yellow and orange vegetables, dairy products, and liver.

Vitamin C

Vitamin C, also known as ascorbic acid, is a vitamin found in specific such as citrus fruits, berries, potatoes and peppers. Vitamin C is the body's tool for healing and fighting off infection, and it also strengthens tissue, muscles, and skin. For healthy doses of vitamin C, look to citrus fruits, strawberries, tomatoes, potatoes, brussels sprouts, spinach, and broccoli.

Vitamin C helps form and repair red blood cells, bones, and tissues. It helps your child's gums stay healthy and strengthens your child's blood vessels, minimizing bruising from falls and scrapes. In addition, vitamin Chelps cuts and wounds heal, boosts the immune system, and keeps infections at bay.

The vitamin C content of food may be reduced by prolonged storage and cooking as it's easily destroyed by heat. You should therefore encourage consumption of raw fruits and veggies where possible or lightly steam veggies. Don't worry if your child is having more than required, as any excess vitamin C that isn't used up by the body is excreted.

How vitamin C helps your body

Vitamin C is important in the formation of

Collagen, blood vessels, cartilage and muscle, and so it helps to maintains the integrity of many body tissues, including the skin. The human body cannot form or produce vitamin C and so depends on outside sources. Plant sources, including tomatoes, peppers, broccoli and kiwi, are the best sources of vitamin C.

Vitamin C is also available as an oral supplement, but over-the-counter sources of vitamins have to be well-researched before taking them on a routine basis. If needed, enlist the help of your physician or pharmacist to choose the right supplement for you.

Consuming adequate vitamin C, also known as ascorbic acid, is important for children. It plays a number of important roles in the body, acting as an antioxidant and immune supporter, helping build the protein collagen and enhancing the absorption of iron in the body.

Antioxidant effects

In the body, vitamin C acts as an antioxidant helping to protect cells from the damage caused by free radicals. Free radicals are compounds formed from normal body processes as well as from exposure to potentially harmful substances such as cigarette smoke, ultraviolet radiation and air pollution. Vitamin C also helps to regenerate the antioxidant vitamin E.

Immune support

Vitamin C is required for normal immune function. It helps maintain immune responses and may play a role in the management of upper respiratory tract infections. When taken regularly, vitamin C may reduce the duration and severity of colds and help relieve cold symptoms.

Collagen and wound healing

The body needs vitamin C to form and strengthen collagen in bones, cartilage, muscles and blood vessels. Vitamin C also helps with the healing of minor wounds and helps your child's teeth and gums stay healthy.

Iron absorption

Vitamin C improves the absorption of iron from the food you eat. This is especially beneficial for kids as their rapid growth imposes high iron requirements

Thiamin

Thiamin (or thiamine) is one of the water-soluble B vitamins. It is also known as vitamin B1. Thiamin is naturally present in some foods, added to some food products, and available as a dietary supplement. This vitamin plays a critical role in energy metabolism and, therefore, in the growth, development, and function of cells (Said, 2010).

Ingested thiamin from food and dietary supplements is absorbed by the small intestine through active transport at nutritional doses and by passive diffusion at pharmacologic doses (Said, 2010). Most dietary thiamin is in phosphorylated forms, and intestinal phosphatases hydrolyze them to free thiamin before the vitamin is absorbed (Said, 2010). The remaining dietary thiamin is in free (absorbable) form (Said, 2010, Bettendorff, 2012). Humans store thiamin primarily in the liver, but in very small amounts (Bemeur, 2014). The vitamin has a short half-life, so people require a continuous supply of it from the diet.

About 80% of the approximately 25-30mg of thiamin in the adult human body is in the form of thiamin diphosphate (TDP; also known as thiamin pyrophosphate), the main metabolically active form of thiamin. Bacteria in the large intestine also synthesize free thiamin and TDP, but their contribution, if any, to thiamin nutrition is currently unknown (Nabokina, 2014).

Food sources of thiamin include whole grains, meat, and fish (Bettendorff, 2012). Pork is another major source of the vitamin. Dairy products and most fruits contain little thiamin (Bemeur, 2014).

Riboflavin

Riboflavin (also known as vitamin B2) is one of the B vitamins, which are all water soluble. Riboflavin is naturally present in some foods, added to some food products, and available as a dietary supplement. This vitamin is an essential component of two major coenzymes, flavin mononucleotide (FMN; also known as riboflavin-5'-phosphate) and flavin adenine dinucleotide (FAD). These coenzymes play major roles in energy production; cellular function, growth, and development; and metabolism of fats, drugs, and steroids (Said, 2012).

The conversion of the amino acid tryptophan to niacin (sometimes referred to as vitamin B3) requires FAD [Institute of Medicine. Food and Nutrition Board]. Similarly, the conversion of vitamin B6 to the coenzyme pyridoxal 5'-phosphate needs FMN. In addition, riboflavin helps maintain normal levels of homocysteine, an amino acid in the blood (Rivlin).

More than 90% of dietary riboflavin is in the form of FAD or FMN; the remaining 10% is comprised of the free form and glycosides or esters (Said, 2014; Institute of Medicine, 1998). Most riboflavin is absorbed in the proximal small intestine (McCormick, 2012). The body absorbs little riboflavin from single doses beyond 27 mg and stores only small amounts of riboflavin in the liver, heart, and kidneys. When excess amounts are consumed, they are either not absorbed or the small amount that is absorbed is excreted in urine (Institute of Medicine, 1998).

Bacteria in the large intestine produce free riboflavin that can be absorbed by the large intestine in amounts that depend on the diet. More riboflavin is produced after ingestion of vegetable-based than meat-based foods (Said, 2014).

The federal government's 2015-2020 *Dietary Guidelines for Americans* notes that "Nutritional needs should be met primarily from foods. ... Foods in nutrient-dense forms contain essential vitamins and minerals and also dietary fiber and other naturally occurring substances that may have positive health effects. In some cases, fortified foods and dietary supplements may be useful in providing one or more nutrients that otherwise may be consumed in less-than-recommended amounts."

Niacin

Niacin (also known as vitamin B3) is one of the water-soluble B vitamins.

All tissues in the body convert absorbed niacin into its main metabolically active form, the coenzyme nicotinamide adenine dinucleotide (NAD).

Most dietary niacin is in the form of nicotinic acid and nicotinamide, but some foods contain small amounts of NAD and NADP. The body also converts some tryptophan, an amino acid in protein, to NAD, so tryptophan is considered a dietary source of niacin.

When NAD and NADP are consumed in foods, they are converted to nicotinamide in the gut and then absorbed (Bourgeois, 2010). Ingested niacin is absorbed primarily in the small intestine, but some are absorbed in the stomach (Penberthy, 2012; Institute of Medicine, 1998).

Niacin is present in a wide variety of foods. Many animal-based foods—including poultry, beef, and fish—provide about 5-10 mg niacin per serving, primarily in the highly bioavailable forms of NAD and NADP. Plant-based foods, such as nuts, legumes, and grains, provide about 2-5 mg niacin per serving, mainly as nicotinic acid. In some grain products, however, naturally present niacin is largely bound to polysaccharides and glycopeptides that make it only about 30% bioavailable (Bourgeois, 2010).

Folate

Folate is a water-soluble B vitamin that is naturally present in some foods, added to others, and available as a dietary supplement. "Folate," formerly known as "folacin" and sometimes "vitamin B9," is the generic term for naturally occurring food folates, and folates in dietary supplements and fortified foods, including folic acid.

Folate functions as a coenzyme or cosubstrate in single-carbon transfers in the synthesis of nucleic acids (DNA and RNA) and metabolism of amino acids [Bailey, 2012; Institute of Medicine, 1998; Stover, 2012]. One of the most important folate-dependent reactions is the conversion of homocysteine to methionine in the synthesis of S-adenosyl-methionine, an important methyl donor. Another folate-dependent reaction, the methylation of deoxyuridylate to thymidylate in the formation of DNA, is required for proper cell division. An impairment of this reaction initiates a process that can lead to megaloblastic anemia, one of the hallmarks of folate deficiency [Carmel, 2005].

When consumed, food folates are hydrolyzed to the monoglutamate form in the gut prior to absorption by active transport across the intestinal mucosa [Institute of Medicine, 1998]. Passive diffusion also occurs when pharmacological doses of folic acid are consumed. Before entering the bloodstream, the enzyme dihydrofolate reductase reduces the monoglutamate form to THF and converts it to either methyl or formyl forms (Baily, 2012). The main form of folate in plasma is 5-methyl-THF.

Folate is also synthesized by colonic microbiota and can be absorbed across the colon. The total body content of folate is estimated to be 15 to 30 mg; about half of this amount is stored in the liver and the remainder in blood and body tissues (Bailey, 2012).

Folate is naturally present in a wide variety of foods, including vegetables (especially dark green leafy vegetables), fruits and fruit juices, nuts, beans, peas, seafood, eggs, dairy products, meat, poultry, and grains.

Minerals

Calcium

Calcium, the most abundant mineral in the body, is found in some foods, added to others, available as a dietary supplement, and present in some medicines (such as antacids). Calcium is required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signaling and hormonal secretion, though less than 1% of total body calcium is needed to support these critical metabolic functions. Serum calcium is very tightly regulated and does not fluctuate with changes in dietary intakes; the body uses bone tissue as a reservoir for, and source of calcium, to maintain constant concentrations of calcium in blood, muscle, and intercellular fluids (Food and Nutrition Boar, 2010).

The remaining 99% of the body's calcium supply is stored in the bones and teeth where it supports their structure and function. Bone itself undergoes continuous remodeling, with constant resorption and deposition of calcium into new bone. The balance between bone resorption and deposition changes with age. Bone formation exceeds resorption in periods of growth in children and adolescents, whereas in early and middle adulthood both processes are relatively equal. In aging adults, particularly among postmenopausal women, bone breakdown exceeds formation, resulting in bone loss that increases the risk of osteoporosis over time [Committee to Review Dietary Reference Intakes for Vitamin D and Calcium 1[2010].

Calcium is important for the health of bones and teeth. Childhood is a key time for calcium consumption at adequate levels. The more bone the children build now, the more reserves they will have when bone loss starts in later years. Consuming inadequate amounts during childhood can affect growth and development, but it can also lead to weak, fragile, and porous bones.

It is essential for growth and development of children and adolescents as it maintains strong bones and teeth while also assisting in muscle contractions, nerve stimulations and regulating blood pressure.

Foods rich in calcium include dairy products like milk, fortified foods, salmon, and dark green leafy vegetables and small fishes eaten with the bones.

Just about every parent knows that children require calcium to build strong bones. It is one of the most abundant minerals in the human body and accounts for approximately 1.5% of total body weight. Bones and teeth contain 99% of the calcium in the body while the remaining 1% is distributed in other areas.

It is during childhood, often referred to as the "bone-forming years," that a child's body is most capable of absorbing calcium. But the fact is, most children and adolescents aren't getting the calcium they need to build peak bone mass. According to statistics from the U.S. Department of Agriculture, 86% of teenage girls and 64% of teenage boys are "calcium deficient."

By the time child reaches age 17, almost 90% of their adult bone mass will already have been established. For this reason, it is of vital importance that your child gets enough calcium on a daily basis.

Iron

Iron is a mineral that is naturally present in many foods, added to some food products, and available as a dietary supplement. Iron is an essential component of hemoglobin, an erythrocyte protein that transfers oxygen from the lungs to the tissues [Wessling-Resnick, 2014]. As a component of myoglobin, a protein that provides oxygen to muscles, iron supports metabolism [Aggett, 2012]. Iron is also necessary for growth, development, normal cellular functioning, and synthesis of some hormones and connective tissue [Aggett, 2012; Murray-Kolbe, 2010].

Iron is important for kids, especially during periods of accelerated growth. Iron contributes to the production of blood and the building of muscles.

Dietary iron has two main forms: heme and nonheme (Wessling-Resnick, 2014). Plants and iron-fortified foods contain nonheme iron only, whereas meat, seafood, and poultry contain both heme and nonheme iron (Aggett, 2012).

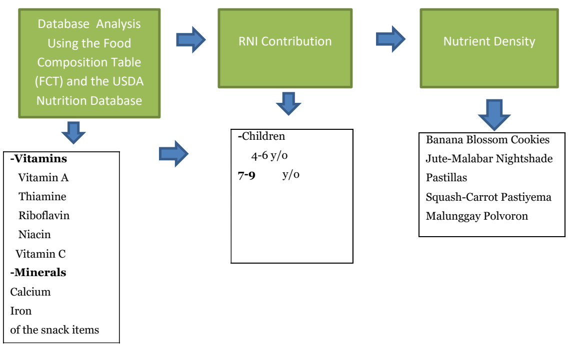
The richest sources of heme iron in the diet include lean meat and seafood (2015–2020 Dietary Guidelines for Americans, 2015]. Dietary sources of nonheme iron include nuts, beans, vegetables, and fortified grain products. Iron is a nutrient that is essential to your child's growth and development. Iron is a mineral that's needed to make hemoglobin, the oxygen-carrying component of red blood cells. Red blood cells circulate throughout the body to deliver oxygen to all its cells. Without enough iron, the body can't make enough Red blood cells, and tissues and organs won't get the oxygen they need. If your child's diet lacks iron, he or she might develop a condition called iron deficiency.

Iron deficiency in children can occur at many levels, from depleted iron stores to anemia — a condition in which blood lacks adequate healthy red blood cells. Untreated iron deficiency in children can cause physical and mental delays.

Importance of Reading Nutrition Labels

The nutrition labels on food packaging can show you which foods contain the proper nutrients and the percentage contribution of the food to the daily diet.

Conceptual Framework



Materials and Methods

The Design

The general objective of this study is to assess the nutritional adequacy of the four processed snack foods. Descriptive research design was utilized.

Procedure

Nutrient Content per Ingredient

The Edible Portions (EP) weights of all ingredients included in each processed food were carefully weighed using the Dietetic Scale. The vitamin and mineral contents of these ingredients were taken from the Food Composition Table (FCT) and USDA Nutrition Database. Calculation of the vitamin and mineral contents of the actual amount of ingredients used in the formulation was performed using the formula:

$$Nutrient\ Content\ Per\ Ingredient = \frac{Calorie\ or\ Nutritive\ Value\ per\ 100\ Grams\ EP}{100} \text{x EP Weight of the ingredient used}$$

Recommended Nutrient Intake (RNI) Contribution

The potential contribution of the snack items to the RNIs of the nutrients of interest for children age 4-6 and 7-9 years old were calculated first by assigning the RNI target for each nutrient as shown in Tables 1 and 2, then calculating the contribution from a standard serving portion of the product (30 grams each) as a percentage of the RNI.

Per cent RNI was computed using the formula:

$$\%RNI = \frac{Nutrient\ content\ per\ serving}{RNIof\ Specific\ Nutrient\ for\ the\ specific\ age\ group} X\ 100$$

The nutrient contents of the snacks were compared with the RNI for Filipinos, 4-6 and 7-9 years old. As a frame of reference, the term "ADEQUATE" will mean that 20 per cent or more of the RNI from the nutrients was contributed and "LESS THAN ADEQUATE" denotes any levels lower than 20 per cent.

Nutrient Density

To determine the most concentrated sources of nutrients among the 4 snack foods, nutrient content per serving portion were calculated.

Vitamin and mineral contents and their percentage adequacy are presented in Tables 1-4.

Result and discussion

A. Nutrient Content and Nutritional Adequacy of the Processed Snack Foods

A.1. Jute-Malabar Nightshade Pastillas

Four vitamins, Vitamin B_1(thiamine), vitamin B_2(riboflavin), Vitamin B_3(niacin) and Vitamin B_9 (folate), and two minerals namely calcium and iron, were determined as to their adequacy among children age 4-6 and 7-9 years old.

Table 1.1. Vitamin and Mineral Contents and Nutritional Adequacy of a serving of Jute-Malabar Nightshade Pastillas for children 4-6 years old.

Vitamins and Minerals	Basis RNI[1]	Vitamin and Mineral Content	Adequacy (Per cent)
Vitamin A (mcg RE)	400	274.49	68.62
Vitamin C (mg)	30	3.035	10.12
Thiamine (mg)	0.6	0.175	29.17
Riboflavin (mg)	0.6	0.42	70
Niacin (mg NE)	7	0.088	1.26
Folate (mcg DFE)	200	13.62	6.81
Calcium (mg)	550	49.54	9.01
Iron (mg)	9	0.28	3.11

[1] RNI for children ages 4-6 years old

Table 1.1 reveals that Vitamin A, thiamine and riboflavin are ADEQUATE in Jute-Malabar Nightshade Pastillas for they met at least 20% of RNI with 68.62, 29.17 and 70% adequacy level, respectively. With the snack item being the sole source, eating two servings of it is enough to meet 100% of the children's need for vitamin A and riboflavin.

Viatmin C, niacin, folate, calcium and iron contents of jute-malabar nightshade infused pastillas are LESS THAN ADEQUATE with percentages of 8.67, 0.98, 4.54, 7.08 and 2.55, respectively.

Table 1.2. Vitamin and Mineral Contents and Nutritional Adequacy of a serving of Jute-Malabar Nightshade Pastillas for children 7-9 years old.

Vitamins and Minerals	Basis RNI[1]	Vitamin and Mineral Content	Adequacy (Per cent)
Vitamin A (mcg RE)	400	274.49	68.62
Vitamin C (mg)	35	3.035	8.67
Thiamine (mg)	0.7	0.175	25
Riboflavin (mg)	0.7	0.42	60
Niacin (mg NE)	9	0.088	0.98
Folate (mcg DFE)	300	13.62	4.54
Calcium (mg)	700	49.54	7.08
Iron (mg)	11	0.28	2.55

[1] RNI for children ages 7-9 years old

Table 1.2 reveals that the vitamins that met at least 20% of RNI are Vitamin A, thiamine and riboflavin with 68.62, 25 and 60% adequacy level, respectively. Eating a serving of jute-malabar nightshade pastillas contribute more than half of the need of children, 4-6 years old for, for vitamin A and riboflavin.

A.2. Banana blossom cookies

Table 2.1. Vitamin and Mineral Contents and Nutritional Adequacy of a serving of Banana Blossom Cookies for children 4-6 years old.

Vitamins and Minerals	Basis RNI[1]	Vitamin and Mineral Content	Adequacy (Per cent)
Vitamin A (mcg RE)	400	566.98	141.75
Vitamin C (mg)	30	1.33	4.43
Thiamine (mg)	0.6	0.114	19
Riboflavin (mg)	0.6	0.10	16.67
Niacin (mg NE)	7	1.51	21.57
Folate (mcg DFE)	200	17.996	8.998
Calcium (mg)	550	22.95	4.17
Iron (mg)	9	1.61	17.89

[1] RNI for children ages 4-6 years old

It is surprising to note that Banana Blossom Cookies exceeded the 100% adequacy level for vitamin A as it attained a percentage of 141.75. A serving of the cookie is more than enough to meet the vitamin A need of children. Niacin, too, met 21.57% adequacy level. All the rest of the nutrients fell below 20% of the RNI. Eating four to five servings of the cookie will supply at least 25% of the RNI for vitamin C and calcium. Eating five pieces of the cookie is more than enough to meet the 100% RNI for riboflavin and iron.

Table 2.2. Vitamin and Mineral Contents and Nutritional Adequacy of a serving of Banana Blossom Cookies for children 7-9 years old.

Vitamins and Minerals	Basis RNI[1]	Vitamin and Mineral Content	Adequacy (Per cent)
Vitamin A (mcg RE)	400	566.98	141.75
Vitamin C (mg)	35	1.33	3.8
Thiamine (mg)	0.7	0.114	16.29
Riboflavin (mg)	0.7	0.10	14.29
Niacin (mg NE)	9	1.51	16.78
Folate (mcg DFE)	300	17.996	5.99
Calcium (mg)	700	22.95	3.28
Iron (mg)	11	1.61	14.64

[1] RNI for children ages 7-9 years old

Only Vitamin A is more than adequate to supply the Vitamin A need of children 7-9 years old by a serving of Banana Blossom Cookie. However, eating two servings of the cookie is enough to meet at least 25% of the RNI for thiamine, riboflavin, niacin and iron. The cookie is a poor source of vitamin C, folate and calcium since their adequacy levels are 3.8%, 5.99% and 3.28%, respectively. It is worthy to note that the main contributor of the vitamin A to the cookie is the orange flesh sweet potato.

In a study conducted by Suyu (2020) on the proximate composition of the banana blossom cookies, it was found out that the ash, crude fat, crude protein, total carbohydrates, moisture, sodium and total calories of cookies prepared with 11.5% incorporation of banana blossom powder, was found to contain 1.93%, 28.32%, 9.84%, 45.59%, 14.34%, 313.18mg/100 g, 476.61kcal/100g, respectively. A serving of the cookie was found "less than adequate" in all the nutrients of interest for age groups 30-49 and 10-12 years old.

Malunngay Polvoron

Table 3.1. Vitamin and Mineral Contents and Nutritional Adequacy of a serving of Malunggay Polvoron for children 4-6 years old.

Vitamins and Minerals	Basis RNI[1]	Vitamin and Mineral Content	Adequacy (Per cent)
Vitamin A (mcg RE)	400	436.07	109.02
Vitamin C (mg)	30	0.756	2.52
Thiamine (mg)	0.6	0.138	23
Riboflavin (mg)	0.6	0.37	61.67
Niacin (mg NE)	7	1.17	16.71
Folate (mcg DFE)	200	29.24	14.62
Calcium (mg)	550	207.51	37.73
Iron (mg)	9	2.24	24.89

[1] RNI for children ages 4-6 years old

Malunggay Polvoron has the most number of nutrients that met at least 25% of the RNI. These nutrients are Vitamin A, thiamine, riboflavin, calcium and iron. The snack item is more than adequate to meet the vitamin A need of children 4-6 years old, with its adequacy level at 109.02%. The nutrient with the lowest adequacy level is vitamin C.

Table 3.2. Vitamin and Mineral Contents and Nutritional Adequacy of a serving of Malunggay Polvoron for children 7-9 years old.

Vitamins and Minerals	Basis RNI[1]	Vitamin and Mineral Content	Adequacy (Per cent)
Vitamin A (mcg RE)	400	436.07	109.02
Vitamin C (mg)	35	0.756	2.16
Thiamine (mg)	0.7	0.138	19.71
Riboflavin (mg)	0.7	0.37	52.86
Niacin (mg NE)	9	1.17	13
Folate (mcg DFE)	300	29.24	9.75
Calcium (mg)	700	207.51	29.64
Iron (mg)	11	2.24	20.36

[1] RNI for children ages 7-9 years old

Table 3.2 reveals that a serving of Malunggay Polvoron is enough to meet the RNI for children age 7-9 years old. In order to supply 100% of the child's need for riboflavin, at least two servings of the snack item must be consumed. Consuming two servings of Malunggay Polvoron is enough to meet 100% of the riboflavin need of children 7-9 years old.

Squash-Carrot Pastiyema

Table 4.1. Vitamin and Mineral Contents and Nutritional Adequacy of a serving of Squash-Carrot Pastiyema for children 4-6 years old.

Vitamins and Minerals	Basis RNI[1]	Vitamin and Mineral Content	Adequacy (Per cent)
Vitamin A (mcg RE)	400	260.98	65.25
Vitamin C (mg)	30	1.05	3.5
Thiamine (mg)	0.6	0.02	3.33
Riboflavin (mg)	0.6	0.603	100.5
Niacin (mg NE)	7	0.69	9.86
Folate (mcg DFE)	200	5.61	2.81
Calcium (mg)	550	6.26	1.14
Iron (mg)	9	0.088	0.98

[1] RNI for children age 4-6 years old

The data on Table 4.1 reveal that the Vitamin A content of a serving of Squash-Carrot Pastiyema is 260.98 mcg RE. It is ADEQUATE as it meets 65.25 per cent of the need of 4-6 year old children for that vitamin. Consuming a serving of the snack item is enough to meet 100% of the riboflavin need of children 4-6 years old. All the rest of the nutrients are LESS THAN ADEQUATE to meet the RNI of this age group.

Table 4.2. Vitamin and Mineral Contents and Nutritional Adequacy of a serving of Squash-Carrot Pastiyema for children 7-9 years old.

Vitamins and Minerals	Basis RNI[1]	Vitamin and Mineral Content	Adequacy (Per cent)
Vitamin A (mcg RE)	400	260.98	65.25
Vitamin C (mg)	35	1.05	3
Thiamine (mg)	0.7	0.02	2.86
Riboflavin (mg)	0.7	0.603	86.14
Niacin (mg NE)	9	0.69	7.67
Folate (mcg DFE)	300	5.61	1.87
Calcium (mg)	700	6.26	0.89
Iron (mg)	11	0.088	0.8

[1] RNI for children ages 7-9 years old

The vitamin A content of a serving of Squash-Carrot Pastiyema is 260.98 mcg RE. It is 65.25 per cent adequate. Riboflavin, on the other hand is 86.14% adequate as it contains 0.603 mg riboflavin per serving. Only these two vitamins are adequate to meet the RNI of children age 7-9 years old. All the rest of the nutrients are LESS THAN ADEQUATE with iron having the lowest adequacy level with only 0.088 mg per serving.

Nutrient Density

Table 5. Nutrient Density of the Processed Snack Items.

Vitamin and Minerals Under Study	Vitamin and Mineral Contents			
	Jute-Malabar Nigthshade Pastillas	Banana Blossom Cookies or Baana Blossom Bar	Malunggay Polvoron	Squash-Carrot Pastiyema
Vitamin A(mcg RE)	274.49	566.98	436.07	260.98
Vitamin C(mg)	3.035	1.33	0.756	1.05
Thiamine(mg)	0.175	0.114	0.138	0.02
Riboflavin(mg)	0.42	0.10	0.37	0.603
Niacin(mg NE)	0.088	1.51	1.17	0.69
Folate(mcg DFE)	13.62	17.996	29.24	5.61
Calcium(mg)	49.54	22.95	207.51	6.26
Iron(mg)	0.28	1.61	2.24	0.088

Table 5 reveals that Banana Blossom Cookies has the greatest vitamin A content followed by Malunggay Polvoron with 566.98 mcg RE and 436.07 mcg RE, respectively. The Jute-Malabar Nigthshade Pastillas has the highest vitamin C. This was contributed by the Malabar nightshade leaves. Thiamine is highest in Jute-Malabar Nigthshade Pastillas. Riboflavin is highest in Squash-Carrot Pastiyema. Banana Blossom Cookies has the highest niacin content among the four snack foods. Malunggay Polvoron got the highest contents of folate, calcium and iron. It is worthy to note that of the four snack items, Malunggay Polvoron is the most nutrient-dense. Table 3.2 also shows that Malunggay Polvoron met 109.02% of the RNI for Vitamin A.

The study of Calubaquib and Suyu(2020) on the proximate composition of fortified Filipino snacks said that fortified Filipino snacks which contain an appreciable amount of nutrients can be a good food supplement for picky eaters needed to maintain a healthier diet. The snack samples fortified with vegetables can be kid-friendly junk food alternatives, and that, if sufficiently consumed, these healthy snacks may contribute to the nutritional requirement of picky-eating children. These snacks may become healthy options for school canteens in the Northern Philippines.

Another study on the nutritional adequacy of banana blossom bar cookies by Suyu (2020) year old revealed that a serving of banana blossom bar cookies contributes 6.68% and 7.45% to the energy need of 10-12 years old, male and female , respectively.

Conclusion

The vegetable-enriched processed snack foods contain precious amounts of vitamins and minerals. Of the six vitamins evaluated, vitamin A is the vitamin supplied in ADEQUATE amounts by the four snack items namely Jute-Malabar Nigthshade Pastillas, Banana Blossom Cookies, Malunggay Polvoron, and Squash-Carrot Pastiyema. In terms of the minerals, calcium and iron, only Malunggay Polvoron met at least 20% of the RNI for these nutrients for both age groups 4-6 and 7-9 years old. All the four snack items supply at least 20% of the RNI for vitamin A and riboflavin for the two age groups. The snack item with the most dense nutrients is Malunggay Polvoron. These snack foods are healthful addition to snacks offered to school children specially those who are picky vegetable eaters. A serving of these snack items are able to supply most of the vitamins and the two minerals needed by these children.

Sensorial qualities to include quality characteristics, consumer acceptance as well as their packaging may be conducted. In addition, development of other nutrient-dense snack items with emphasis on the incorporation of leafy and fiber-rich vegetables is encouraged.

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