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STUDY ON MILK POWDER CONTENTS FOR INFANTS AND CHILDRENS GROWTH IN MALAYSIA

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ABSTRACT

Milk has been consumed since time immemorial because of its unique nutritional properties and produced almost 816 million tonnes in the year of 2016. Due to its highly perishable characteristic, milk is processed into more stable milk products such as cheese, yogurt, butter, and milk powder. Therefore, it is widely used in many food products such as ice cream, bakery products, and usages. Milk is an important nutrition for infants and kids aged 1 to 6 years old. It is important for child development in terms of brain development, bone formation, and others. Milk is processed into powder form. The Milk Powder is produced by various companies using numerous names and brands with approval of the relevant authorities. In this paper, the contents of the nine main brands of infant milk powder namely " Friso Gold", "S-26 Promise", "Anmum Essential", "Enfagrow A+","Sustagen Kid 3+", "Pediasure", "Similac", "Lactokid", and "Nankid", used in Malaysia been analyzed and presented the outcoming in term of comparison. The method used by performing a comparison between these nine brands to determine which of these brands is most suitable for daily consumption in terms of its advantages with minerals and vitamin content for children's health and development. From the analysis by comparing each mineral and vitamin by brand, Pediasure milk powder is proven to be better when compared with other eight brands for daily minerals and vitamin consumption for infants till 3 years of child growth. This is followed by Similac, Lacktokid, Nankid, and Sustagen Kid 3+ brand. The finding and outcome recommended by this paper will be useful for a consumer in choosing suitable milk powder by minerals and vitamins needed as supplementary for daily in a child growth concerning age limit.

Keywords: Milk Powder,Minerals, Vitamins,Brand,Comparison

1.0 INTRODUCTION

Milk contains 3.3% total protein. Milk proteins contain all 9 essential amino acids required by humans. Milk proteins are synthesized in the mammary gland, but 60% of the amino acids used to build the proteins are obtained from the cow's diet. Fat has more nutritional energy per cup, but researchers [1] found that in general low-fat milk drinkers do absorb less fat, and will compensate for the energy deficit by eating more carbohydrates. They also found that the lower milk fat drinkers also ate more fruits and vegetables, while the higher milk fat drinkers also ate more meat and sweets[2]. Minerals and vitamins are one of the most important content in every milk powder product. The growth of infants and children need these in their daily intake or meals. Nine (9) nutrients mostly need for the growth of a child. The nutrients are Protein, Carbohydrates, Fats, Calcium, Iron, Folate, Fiber, Vitamin A, and Vitamin C [3]. Besides this, Vitamin B, D, E, and K are also needed in a child's growth. As fast as children from the classroom activities to their home and back again, their brains are just as rapidly growing and changing. The foods they eat are important. These vitamins needed for brain development, affects focus and cognitive skills. Seven (7) foods can help kids stay sharp and affect how their brains develop well into the future are Eggs, Greek Yogurt, Greens, Fish, Nuts, Seeds, Oatmeal, Apples and Plums [4]. Table 1 shows a summary of minerals and vitamins need for child's growth [5].

Table 1: Table of importance of Minerals and Vitamins

Seq	Minerals	Importance	Vitmains	Importance
1	Calcium	Helps build strong bones and teeth.	Vitamin A	Keeps skin, hair, vision, and the immune system healthy
2	Fat	Creates energy, helps the brain develop, keeps skin and hair healthy, and protects against infections.	Vitamin B1	Helps the body turn food into energy.
3	Folate	Helps cells divide.	Vitamin B2	Helps the body turn food into energy and protects cells from damage.
4	Iron	Builds blood cells, and helps the brain develop. Breast-fed babies should receive iron supplements	Vitamin B3	Helps the body turn food into energy and use fats and protein
5	Protein	They provide energy and fuel growth.	Vitamin B6	Keeps the brain and immune system healthy
6	Carbohydrates			
7	Zinc	Helps the cells grow and repair themselves	Vitamin B12	Keeps nerve and blood cells healthy, and makes DNA the genetic material in every cell.
8			Vitamin C	Protects against infections, builds bones and muscles, and helps wounds heal.
9			Vitamin D	Helps the body absorb calcium from food, and keeps bones

10			Vitamin E	Protects cells from damage, and strengthens the immune system.
11,			Vitamin K	Helps the blood to clot.

2.0 MINERALS

2.1 CALCIUM

Calcium is a nutrient that builds strong bones. It helps the body in lots of other ways too. Calcium keeps the nerves and muscles working. It also plays a role in keeping the heart-healthy. Kids need more calcium as they get older to support their growing bones. Studies show that kids from 1 to 3 years old need 700 mg of calcium a day with 2 to 3 servings. Meanwhile, kids from 4 to 8 years old need 1,000 mg of calcium a day with 2 to 3 servings [6]. Among the 9 milk powder brand, Anmum essential has the highest amount of calcium with 1040mg followed by Similac with 975mg and Lactokid with 875mg.

2.2 PHOSPHORUS

Phosphorus is a mineral found in your bones. Along with calcium, phosphorus is needed to build strong healthy bones, as well as, keeping other parts of your body healthy. Normal working kidneys can remove extra phosphorus in your blood. When you have chronic kidney disease (CKD), your kidneys cannot remove phosphorus very well. High phosphorus levels can cause damage to your body. Extra phosphorus causes body changes that pull calcium out of your bones, making them weak. High phosphorus and calcium levels also lead to dangerous calcium deposits in blood vessels, lungs, eyes, and heart. Over time this can lead to increased risk of heart attack, stroke, or death. Phosphorus and calcium control are very important for your overall health [7]. The amount of phosphorus you need in your diet depends on your age. Adults need less phosphorus than children between the ages of 9 to 18, but more than children under 8 years old. The Linus Pauling Institute recommends the following daily intake: adults (19 years and older): 700 mg, children, (9 to 18 years): 1,250 mg, children (4 to 8 years): 500 mg, children (1 to 3 years): 460 mg, infants (7 to 12 months): 275 mg, infants (0 to 6 months): 100 mg. Most people can get the necessary amount of phosphorus through the foods they eat. Too much phosphate can be toxic. An excess of the mineral can cause diarrhea, as well as a hardening of organs and soft tissue. High levels of phosphorus can affect your body's ability to effectively use other minerals, such as iron, calcium, magnesium, and zinc. It can combine with calcium causing mineral deposits to form in your muscles. It's rare to have too much phosphorus in your blood. Typically, only people with kidney problems or those who have problems regulating their calcium develop this problem [8].

2.3 SODIUM

Our body needs some sodium to function properly because it helps maintain the right balance of fluids in your body, helps transmit nerve impulses, and influences the contraction and relaxation of muscles. Your kidneys naturally balance the amount of sodium stored in your body for optimal health. When the sodium in the body is low, the kidneys essentially hold on to the sodium. Meanwhile, when the sodium in the

body is high, the kidneys excrete the excess in urine [9]. Babies and children only need a very small amount of salt in their diet. However, because salt is added to a lot of the food you buy, such as bread, baked beans, and even biscuits, it is easy to have too much. The maximum recommended amount of salt for babies and children up to 12 months – less than 1g of salt a day (less than 400 mg sodium), children from 1 to 3 years: 2g of salt a day (800 mg sodium) and 4 to 6 years: 3g of salt a day (1200 mg sodium) [9].

2.4 IRON

Iron is an essential mineral. The major reason we need it is that it helps to transport oxygen throughout the body. Iron is an important component of hemoglobin, the substance in red blood cells that carries oxygen from your lungs to transport it throughout your body. Hemoglobin represents about two-thirds of the body's iron. If you don't have enough iron, your body can't make enough healthy oxygen-carrying red blood cells. A lack of red blood cells is called iron deficiency anemia. Without healthy red blood cells, your body can't get enough oxygen. Iron has other important functions, too. Iron is also necessary to maintain healthy cells, skin, hair, and nails [10]. The recommended intake of iron for infants from 0 to 6 months: 0.27 milligrams (mg) while from 7 to 12 months: 11 mg. Meanwhile, for children from 1 to 3 years: 7 mg and from 4 to 8 years: 10 mg [11].

2.5 COPPER

Copper, an essential mineral, is naturally present in some foods and is available as a dietary supplement. It is a cofactor for several enzymes (known as "cuproenzymes") involved in energy production, iron metabolism, neuropeptide activation, connective tissue synthesis, and neurotransmitter synthesis. One abundant cuproenzyme is ceruloplasmin (CP), which plays a role in iron metabolism and carries more than 95% of the total copper in healthy human plasma. Copper is also involved in many physiologic processes, such as angiogenesis, neurohormone homeostasis, and regulation of gene expression, brain development, pigmentation, and immune system functioning. Besides, defense against oxidative damage depends mainly on the copper-containing superoxide dismutases. The recommended intake of Copper, from birth to 6 months: 200 ug, 7–12 months: 200 ug, 1–3 years: 340 ug and 4–8 years: 440 ug [12]

2.6 POTASSIUM

Potassium is one of the seven essential macrominerals. The human body requires at least 100 milligrams of potassium daily to support key processes. Potassium carries proven health benefits. Potassium supports blood pressure, cardiovascular health, bone strength, and muscle strength [13]. The recommended intake of Potassium for children from 1 to 3 years of age: 3,000 mg/day while from 4 to 8 years of age: 3,800 mg/day [14].

2.7 MAGNESIUM

Magnesium is a nutrient that the body needs to stay healthy. Magnesium is important for many processes in the body, including regulating muscle and nerve function, blood sugar levels, and blood pressure and making protein, bone, and DNA. The recommended intake of Magnesium, from birth to 6 months: 35mg,

an infant from 7-12 months: 75mg, while for children from 1-3 years: 80mg and from 4-8 years: 130 mg [15].

2.8 MANGANESE

Manganese is a trace mineral. It is vital for the human body, but people only need it in small amounts. Manganese contributes to many bodily functions, including the metabolism of amino acids, cholesterol, glucose, and carbohydrates. It also plays a role in bone formation, blood clotting, and reducing inflammation [16]**.** The recommended intake of Manganese, the daily Adequate Intake (AI) levels for manganese are: infants from birth to 6 months: 0.003 mg, while from 7 to 12 months: 0.6mg. Meanwhile, children from 1 to 3 years: 1.2 mg, while from 4 to 8 years: 1.5 mg [17].

2.9 ZINC

Zinc is an important trace mineral that people need to stay healthy. Of the trace minerals, this element is second only to iron in its concentration in the body. Zinc is found in cells throughout the body. It is needed for the body's defensive (immune) system to work properly. It plays a role in cell division, cell growth, wound healing, and the breakdown of carbohydrates. Zinc is also needed for the senses of smell and taste. During childhood the body needs zinc to grow and develop properly. Zinc also enhances the action of insulin [18]. The recommended intake of Zinc for infants 0-6 months: 2mg, from 7-12 months: 3mg, while for children from 1-3 years: 3mg and from 4-8 years: 5mg [19].

2.10 SELENIUM

Selenium is an essential mineral, meaning it must be obtained through your diet. It's only needed in small amounts but plays a major role in important processes in your body, including your metabolism and thyroid function. 7 benefits of Selenium are acts as a powerful antioxidant, may reduce your risk of certain cancers, may protect against heart disease, help prevent mental decline, is important for thyroid health, boosts your immune system, and may help reduce asthma symptoms [20]. The recommended intake for Selenium is 20 mcg for children from 1-3 years and 30 mcg for children 4-8 years [21].

2.11 GANGLIOSLIDES (ANMUM ESSENTIAL)

In humans, brain growth occurs from 12 weeks of gestation through the first three years of infancy. Adequate nutrition to support the rapid growth and development of the brain during this period is paramount. Nutritional deprivation results in impaired development, fewer neuronal connections, impaired synaptic connectivity, and irreversible consequences for cognitive function throughout life. It is widely accepted that gangliosides play a critical role in neuronal function and brain development, affecting such processes as neurotransmission, neurogenesis, synaptogenesis, modulating synaptic transmission, cell proliferation, and neuronal differentiation. Many of these processes are fundamental to the so-called neuroplasticity of the brain i.e. the ability of the brain to undergo the activity-dependent functional and morphological remodeling which subserves learning and memory. While prenatal brain development mainly involves neurogenesis and migration, postnatal brain development largely involves remodeling, specifically vascular remodeling, white matter (myelin) development, and synaptic development and

pruning. The most dramatic brain remodeling takes place during the first postnatal year but remodeling continues throughout life such that the mature adult brain retains considerable functional plasticity [22].

2.12 IODINE

Iodine is a mineral found in some foods. The body needs iodine to make thyroid hormones. These hormones control the body's metabolism and many other important functions. The body also needs thyroid hormones for proper bone and brain development during pregnancy and infancy. Getting enough iodine is important for everyone, especially infants and women who are pregnant. The recommended intake of iodine for infants from birth to 6 months: 110mg, while infants from 7-12 months: 130mg. Meanwhile, children from 1-8 years need 90mg [23].

2.13 CARNITINE (PEDIASURE)

Carnitine, derived from an amino acid, is found in nearly all cells of the body. Its name is derived from the Latin carnus or flesh, as the compound was isolated from meat. Carnitine is the generic term for several compounds that include L-carnitine, acetyl-L-carnitine, and propionyl-L-carnitine. Carnitine plays a critical role in energy production. It transports long-chain fatty acids into the mitochondria so they can be oxidized ("burned") to produce energy. It also transports the toxic compounds generated out of this cellular organelle to prevent their accumulation. Given these key functions, carnitine is concentrated in tissues like skeletal and cardiac muscle that utilize fatty acids as a dietary fuel. Healthy children and adults do not need to consume carnitine from food or supplements, as the liver and kidneys produce sufficient amounts from the amino acids lysine and methionine to meet daily needs [24].

2.14 LUTEIN (SIMILAC)

Lutein is a type of vitamin called a carotenoid. It is related to beta-carotene and vitamin A. Foods rich in lutein include egg yolks, broccoli, spinach, kale, corn, orange pepper, kiwi fruit, grapes, orange juice, zucchini, and squash. Lutein is absorbed best when it is taken with a high-fat meal. Many people think of lutein as 'the eye vitamin.' It is commonly taken by mouth to prevent eye diseases such as an eye disease that leads to vision loss in older adults (age-related macular degeneration or AMD), and cataracts. There is no good scientific evidence to support the use of lutein for other conditions. Many multivitamins contain lutein. They usually provide a relatively small amount, such as 0.25 mg per tablet. Lutein is one of two major carotenoids found as a color pigment in the human eye (macula and retina). It is thought to function as a light filter, protecting the eye tissues from sunlight damage [25]

3.0 METHODOLOGY

In this research, a comparison methodology is used. The nine most popular milk powder brands available in the Malaysian market had been chosen. The label for each brand had been removed and a comparative study of the contents for each brand was made. Table 2 Nutritional Information for milk products per 100g powder has been analyzed. Furthermore Table 3 and Table 4 comparison of minerals and vitamins have been analyzed for all the nine milk powder products sold at the Malaysian market. Besides, comparison studies have been made by comparing the standard requirement gazetted. The outcome of

the comparative study allows us to recommend the most suitable milk powder for consumption in terms of health concerns.

4.0 RESULT AND DISCUSSION

Milk powder contains commonly known minerals and vitamins [1][2]. Minerals have many roles in the body including enzyme functions, bone formation, water balance maintenance, and oxygen transport. Milk is a good source of calcium, magnesium, phosphorus, potassium, selenium, and zinc. Many minerals in milk are associated together in the form of salts, such as calcium phosphate. In milk approximately 67% of the calcium, 35% of the magnesium, and 44% of the phosphate are salts bound within the casein micelle and the remainder are soluble in the serum phase. The fact that calcium and phosphate are associated as salts bound with the protein does not affect the nutritional availability of either calcium or phosphate. Milk contains small amounts of copper, iron, manganese, and sodium and is not considered a major source of these minerals in the diet.[26] Vitamins have many roles in the body, including metabolism co-factors, oxygen transport, and antioxidants. They help the body use carbohydrates, protein, and fat. Milk contains the water-soluble vitamins thiamin (vitamin B1), riboflavin (vitamin B2), niacin (vitamin B3), pantothenic acid (vitamin B5), vitamin B6 (pyridoxine), vitamin B12 (cobalamin), vitamin C, and folate. Milk is a good source of thiamin, riboflavin, and vitamin B12. Milk contains small amounts of niacin, pantothenic acid, vitamin B6, vitamin C, and folate and is not considered a major source of these vitamins in the diet. Milk contains the fat-soluble vitamins A, D, E, and K. The content level of fat-soluble vitamins in dairy products depends on the fat content of the product. Reduced-fat (2% fat), low-fat (1% fat), and skim milk must be fortified with vitamin A to be nutritionally equivalent to whole milk. Fortification of all milk with vitamin D is voluntary. Milk contains small amounts of vitamins E and K and is not considered a major source of these vitamins in the diet [26].

Table 2: Nutritional Information for Milk Products per 100g powder

Name of Milk Powder	Energy(kcal)	Protein(g)	Fat(g)	Carbohydrate(g)	Dietary Fibre(g)
Friso Gold	438	15.5	13.2	62.7	1.8
S-26 Promise	450	17	15	62	0
Anmum Essential	446	25.4	19.2	40.8	4.3
Enfagrow A+	430	15.5	13.5	63	3.2
Sustagen Kid 3+	430	14.5	15	60	0
Pediasure	443	13.26	35	53	0
Similac	484	18.2	22.8	50.5	0
Lactokid	486	14.6	21	59.7	0
Nankid	455	13.7	18.6	58.3	0

From Table 2, five basic needs for early child growth nutrition have been analyzed. The energy level is determined by the age of a child versus calories, according to literature amount of protein for infant till 3-year-old children should be no more than 19g [27]. Meanwhile, for fats contain, it should not be more than 39g for infant till 3-year-old children [28]. However, the amount of carbohydrate according to literature should not be exceeded 60g for infant till 3-year-old children [28] and dietary fibre should be

zero to avoid obesity for infant till 3-year-old children [30]. From the analysis of table 2, it is found the top milk powder brands in the sequence are Pediasure, Similac, Lactokid, Nankid, Sustagen kid 3+ and S-26. All the nutrition requirements as stated in Table 2 are met. However, milk powder brands like Friso Gold, Annum Essential and Enfagrow A+ produce dietary fibre, more protein and carbohydrate level in the milk powder.

Table 3: Table of Minerals for Milk powder per 100g powder

Name of Milk Powder	Calcium(mg)	Phosphorus(mg)	Sodium(mg)	Iron(mg)	Copper(ug)	Potassium(mg)	Chloride(mg)	Magnesium(mg)	Manganese(mg)
Friso Gold	530	435	175	7.5	190	690	425	48	0.64
S-26 Promise	495	450	248	5.6	200	721	450	59	~
Anmum Essential	1040	680	~	11	44	~	~	77	~
Enfagrow A+	750	~	~	9	~	~	~	75	~
Sustagen Kid 3+	580	~	~	6	~	~	~	50	~
Pediasure	445	384	169	6.99	440	769	451	107.1	0.84
Similac	975	582	250	6.8	370	700	520	~	0.09
Lactokid	875	486	344	6.1	~	~	~	69	~
Nankid	712	~	~	7.2	~	~	~	56	~

Name of Milk Powder	Zinc(mg)	Selenium(µg)	Gangliosides(mg)	Iodine(µg)	Carnitine(mg)	Lutein(µg)
Friso Gold	4.5	16	~	125	~	~
S-26 Promise	5.4	~	~	45	~	~
Anmum Essential	9	7.6	100	55	~	~
Enfagrow A+	6.3	15	~	15	~	~
Sustagen Kid 3+	5.5	8.3	~	58	~	~
Pediasure	3.1	14.2	~	43.1	7.52	~
Similac	4.5	12.3		100	~	135
Lactokid	4.3	~	~	100	~	~
Nankid	5.3	11	~	73	~	~

From Table 3, ten basic need minerals for early child growth have been analyzed. From literature, the amount contains for each mineral has been mentioned for infants to a 3-year-old child [3]. List of minerals needed for child growth can be explained by looking at the content in milk powder. Minerals like calcium should be in between 700g-1000g, phosphorus in between 275g-460g, sodium in between 1g-2g, iron in between 0.27g-7g, copper in between 220mg -440mg, potassium below 3000g, chloride at 400mg, magnesium in between 35g-130g, manganese in between 0.03mg-1.20mg, zinc in between 2mg-3mg, selenium by 20mg and iodine in between 110ug-130ug. From the analysis in Table 3, it is found top milk powder brands in the sequence are Pediasure, Similac, Lactoki, Nankid and S-26. All the minerals requirement as stated in Table 3 are met.

Table 4: Table of Vitamins for Milk powder per 100g powder

Name of Milk Powder	Vit A (ug)	Vit B1 (ug)	Vit B2 (ug)	Vit B6 (ug)	Vit B12 (ug)	Vit C (mg)	Vit D (ug)	Vit E (mg)	Vit K (ug)
Friso Gold	450	450	445	855	1.6	105	9.5	7.1	26
S-26 Promise	486.6	405	721	450	2.0	45	4.5	5.04	-
Annum Essential	380	500	1300	500	2.8	33	5.9	9.4	15
Enfagrow A+	440	950	850	950	1.9	55	3.5	6.0	26
Sustagen Kid 3+	330	500	700	500	1.2	48	4.8	2.1	24
Pediasure	266	1160	940	1160	1.3	44.3	8.85	6.8	26.1
Similac	423	360	1000	360	3.0	71.6	5.9	7.4	46
Lactokid	456	600	900	600	1.0	97	6.1	6.3	31
Nankid	473	400	800	400	0.9	88.6	7.5	4.4	33.5

From Table 4, nine basic vitamins needs for early child growth have been analyzed. From literature, the amount contains for each vitamin has been mentioned for infants to a 3-year-old child [3][4][5]. List of vitamins needed for child growth can be explained by looking at the content in a milk powder. Vitamins like Vitamin A should be in between 300ug-400ug, vitamin B1 in between 200ug-500ug, vitamin B2 in between 400ug-600ug, vitamin B6 in between 200ug-700ug, vitamin B12 in between 0.3ug-0.5ug, vitamin C in between 25mg-30mg, vitamin D below 15ug, vitamin E below 4mg and vitamin K in between 27ug-67ug. From the analysis in Table 4, it is found the top milk powder brand in the sequence are Pediasure, Similac, Lactokid, Nankid and Sustagen kid 3+. Most of the vitamins requirements as stated in Table 4 are met.

5.0 CONCLUSION

From the analysis by comparing each mineral and vitamin by brand, Pediasure milk powder is proven to the best when compared with other eight brands for daily minerals and vitamins consumption for the growth of infants till 3 years old. This is followed by brands such as Similac, Lactokid, Nankid and Sustagen Kid 3+. There are some differences in milk powder in term of extra mineral contains which is good for children's growth for example Pediasure contains 'Camitine' which is good for energy production. Meanwhile, Similac contains 'Lutein' for better eyesight while Anmum Essential contains 'Gangliosides' which plays a critical role in neuronal function and brain development. The finding and outcome recommended by this paper will be useful for a consumer in choosing suitable milk powder following minerals and vitamins needed as supplementary for daily in a child growth regarding age limit. Further analysis can be adapted for research by choosing similar or different brands available in the global market to concrete the findings of this study.

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