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Are there Organoleptic Differences between Fortified Pure Natural Milk and Fortified Constituted Milk?

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Introduction

Stunting is common in developing countries, resulting in high mortality rate and diseases[1]. Micronutrient Deficiency (MD) is one of the main reasons for the current state of stunting[2]. MD has led to children unable to develop both the mentality and physicality to its optimal; iron, zinc and iodine when are deficient have negative effects on the development of children[3]. Therefore, intervention to improve the MD status is essential in developing countries including Vietnam. The Copenhagen Consensus of 2012 has recognized the big effects of these interventions and has deemed them imperious with high cost-effective values in improving public health of developing and affected countries[4].

The reason for MD is the dietary intake unable to provide necessary micronutrients for body demands[5,6]. In the same subject group, it is more common to see multiple micronutrients deficiency than a single vitamin or mineral[7-9]. MD, especially vitamin A, iron, zinc and iodine, is a public health problem in Vietnam with children as the main target. In Vietnamese dietary intake, average iron intake is 6.5mg/day, reaching only 73% of the recommended dietary allowances (RDA)[10,11]. Vitamin A meets 65% of the RDA. In the North, Central Highlands and Central Vietnam, retinol vitaminA reach 34%, 36% and 42% of the RDA, respectively[10]. According to the national nutrition survey in 2010, in groups of Vitamin D and/or Calcium rich foods, fish and tofu consumption in children is 11% while all dairy products is 19% daily. This shows that, the average vitamin D and calcium consumption of children under the age of 5 is approximately 0.5µg/person/day and 256.8 mg/person/day, respectively. These consumptions only provide 60.3% average calcium requirements and 10.6% average Vitamin D requirements for children between the age of 1 and 3[10].

Pre-puberty and puberty is an important stage in developing a child's physicality, requiring focus both in nutrients intake and exercises[12]. Nutrients supplementation is essential to prevent and control MD in the diets of this age. "School milk" is one of the strategic programs with the aim to improve nutrition status for children aged 6 to 12. Fortifying micronutrients in milk is thus a tool to provide more micronutrients in diet to meet the children's RDA and is one of the sustainable and cost effective interventions. Vietnam has already implemented food fortification programs for years; milk is food vehicle with advantages of fortifying micronutrients for school age children. The program is supported by the government and society nationwide. Furthermore, micronutrients such as iron, Vitamin A, zinc and Vitamin B groups can also be fortified to milk. There are several studies showing sensory acceptability and effectiveness of single micronutrient fortified milk (iron, zinc) in improving nutritional status. However, there is not study on the organoleptic acceptability of multi-micronutrients fortified milk.

Vietnam is a country with milk consumption remaining low (around 19%). In order to increase this rate, and improve effectiveness of multi micronutrients fortified milk for school age children, sensory acceptability of micronutrient fortified milk requires to be studied carefully before producing nationwide. Therefore, the aim of the research is to assess the sensory acceptability and acceptance to micronutrient fortified milk. The result of this research is the basis to create micronutrients fortified milk with the formula and sensory appropriate for different age groups, allowing the development of the program on a nationwide scale.

Methods and Subjects

Prospective study is conducted to evaluate organoleptic characteristics together with the effectiveness study.

Research product: Milk used in research are provided by Vinamilk Corp. consist of 100% natural milk which is branded 100%

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natural milk and constituted milk which is branded ADM gold. Micronutrients fortified formula for both types of milk were designed based on recommendations of the WHO[7]and Nutritional Requirements for Vietnamese people to increase micronutrients for children age 2 to 12. All products have labels with the formula imprinted and legalized on the market based on Vietnam Food Administration and the Ministry of Health.

Research subjects: Children were chosen from 2094 subjects from 6 primary school of 5 communities of PhuBinh District, Thai Nguyen Province. These children consumed milk based on effectiveness study of fortified micronutrient pure 100% milk and that of constituted milk.

Research design: Children participated in the research were chosen from 2 groups of the effectiveness study of fortified micronutrient milk and the micronutrients status of which one group drink 100% pure fortified micronutrient milk (100% pure milk) and another drinks fortified micronutrient constituted milk (ADM Gold)

Children participating in the research drink 2 boxes of milk 180 ml each day and drink designated type of milk for that research group. Time of consumption is around 9:00 a.m and 3:00 p.m. Teachers distributed the milk and checked whether it was fully consumed, recorded the amount of milk consumed and medical record (if present) of children in the process of research. Analysis of main nutrients level includes lipid, protein, carbohydrate and calcium to ensure those in both milks are similar. The formula for micronutrients fortification of both milks is also similar.

After 6 months of intervention, organoleptic study was implemented for approximately 20% of the research subjects and 360 children from two genders and aged from 1 grade to 4 grade were chosen in the two groups. The group of 100% pure milk had 188 children and the group of ADM Gold milk had 172.

Criteria for organoleptic assessment: Children participating in the organoleptic assessment were asked their feeling about criteria of color, smell, taste, flavorful and overall acceptance of fortified micronutrients milks and rated each criteria following the Hedonic scale from 1 (terrible) to 9 (great). Points from 6-9 is consider sensory acceptance, 5 is neutral and 1 to 4 is sensory unacceptance.

Organoleptic study was conducted inside rooms at school. Researchers who were trained at National Institute of Nutrition (NIN) carried out the assessment.

Statistics analysis

Data of organoleptic assessment were checked for normality using the Shaprio-Wolk test and it did not follow the normal distribution.

Differences in proportion of acceptance and unacceptance of organoleptic characteristics were done using Chi-square test. p-value of 0.01 was used as the baseline for significant difference. Fisher extract test was used to assess the difference between the two groups. Data was analyzed using PASW statistics software 20.0 (SPSS Inc., U.S.A.)

Results

Nutritional value of fortified micronutrients milk

Table 1: Nutritional values of fortified micronutrients milk for both types

Ingredient	Nutritional value of a 180ml carton of milk		Ingredient	Nutritional value of a 180ml carton of milk	
Vitamin A	114.00	µg	Lipid	6.10	g
Vitamin D	1.90	µg	Protein	5.40	g
Vitamin E	1.20	mg	Carbohydrate	8.10	g
Vitamin K	4.68	µg	Calcium	216.00	mg
Vitamin C	12.00	mg	Iron	2.70	mg
Vitamin B1	180.00	µg	Zinc	2.25	mg
Vitamin B2	250.00	µg	Copper	130.00	µg
Vitamin B3	2.00	Mg	Selen	6.00	µg
Acid Pantothenic	0.52	mg	Iodine	27.00	µg
Vitamin B6	150.00	µg	Magnesium	21.24	mg
Acid Folic	54.00	µg	Lysine	450.0	mg
Vitamin B12	0.30	µg	Taurine	12.6	mg
Biotin	3.60	µg			

Following the Vietnamese RDA, portions of 2 180 ml milk cartons daily meet the RDA of different age groups of energy from 6.6% to 10.7%, of protein 10.8% to 21.6%, of vitamin A from 19% to 25.3%, of vitamin D approximately 12.7%, of minerals from water from 13% to 36%, and minerals from iron from 15% to 10.9%, zinc from 16.7% to 30% and other minerals from 10.1% to 36 % .(figure 1, 2, 3, 4).

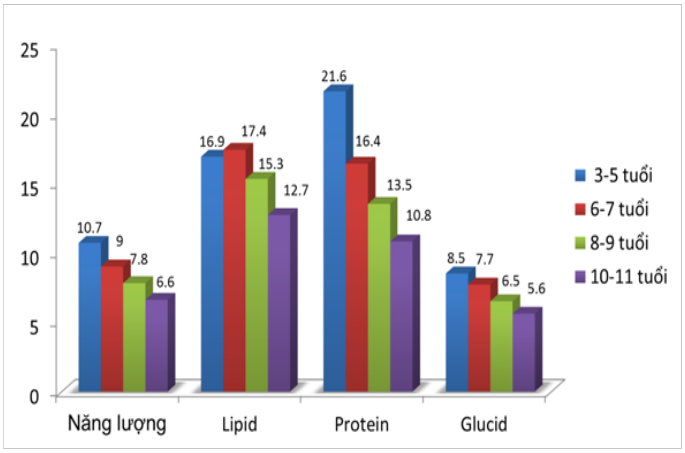

Figure 1: Energy and main nutrients in a carton of fortified micronutrients milk 180 ml compared to RDA of children in different age groups.

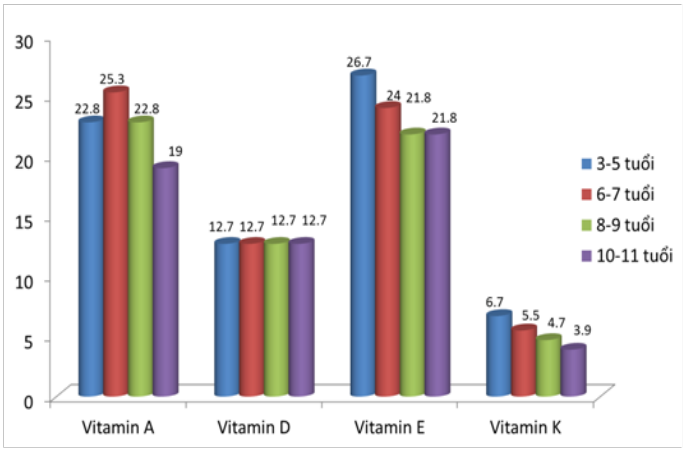

Figure 2: Fat soluble vitamins levelin a carton of fortified micronutrients milk 180 ml and RDA of children in different age groups.

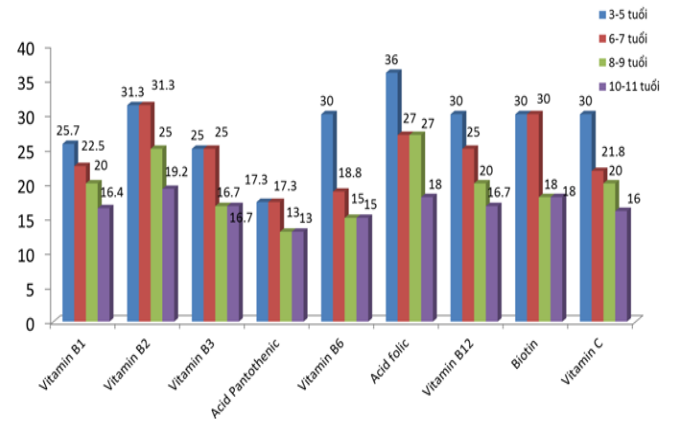

Figure 3: Water soluble vitaminsin a carton of fortified micronutrients milk 180 ml and RDA of children in different age groups.

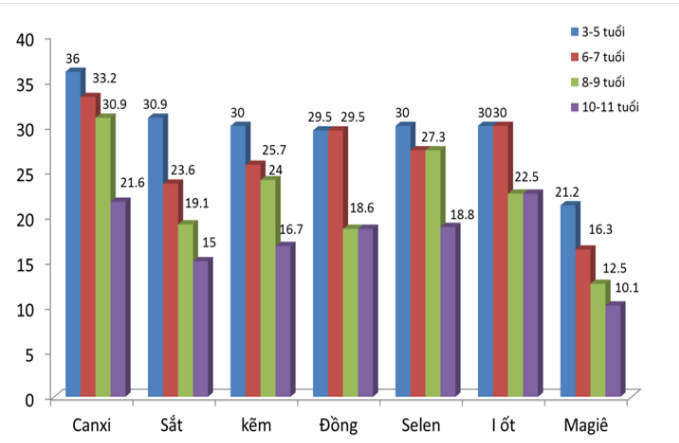

Figure 4: Minerals satisfaction in a carton of fortified micronutrients milk 180 ml and nutritional requirements of children in different age groups.

Characteristics of children participating organoleptic assessment

Number of children participating in organoleptic assessment of 100% pure milk with micronutrients fortification is 188 with 96 males and 92 females. Number of children participating in organoleptic assessment of ADM Gold milk with micronutrients fortification is 172 with 89 males and 83 females. Children are mainly in 2nd, 3rd and 4th grade in primary school that is also in intervention research. There are 11, 1st grade participating in the research. This is the smallest grade in primary school so only few are selected.

Table 2: A few characteristics of children participating in research

Characteristics	100% pure		ADM Gold	
	N	%	N	%
Male	96	26,6	89	24,7
Female	92	25,6	83	23,1
Total	188	52,2	172	47,8
1st grade	6	1,6	5	1,4
2nd grade	65	18,1	63	17,5
3rd grade	57	15,8	54	15,0
4th grade	60	16,7	50	13,9
Total	188	52,2	172	47,8

Table 3: Organoleptic acceptance of two types of milk in school children

COLOR	**100% pure**			**ADM Gold**		
	N	Percent	P*	N	Percent	P*
Neutral	2	1.1	< 0.0001	5	2.9	< 0.0001
Positive	186	98.9		167	97.1	
Negative	0	0		0	0	
Total	188	100		172	100	
SMELL						
Neutral	5	2.7	< 0.0001	1	0.6	< 0.0001
Positive	182	96.8		168	97.7	
Negative	1	0.5		3	1.7	
Total	188	100				
TASTE						
Neutral	2	1.1	< 0.0001	4	2.3	< 0.0001
Positive	185	98.4		168	97.7	
Negative	1	0.5		0	0	
Total	188	100		172	172	
FLAVOR						
Neutral	0	0		1	0.6	< 0.0001
Positive	186	98.9	< 0.0001	168	97.7	
Negative	2	1.1		3	1.7	
Total	188	100		172	100	
OVERALL ACCEPTANCE						
Neutral	0	0		3	1.7	< 0.0001
Positive	187	99.5	< 0.0001	167	97.1	
Negative	1	0.5		2	1.2	
Total	188	100		172	100	

*Chi-square test, p-value < 0.0001 show a significant difference in the scale. As shown in the table, acceptance is significant larger than unacceptance.

In 360 kids participating in the event of 6 months of using micronutrients-increased milk, most provide a positive to very positive answer to all senses, including color, taste, and smell, flavorful and overall acceptance. Very few dislike and

strongly disliked the product (p-value < 0.0001). Overall acceptance showed that very few children from both groups had signs of sensory unacceptance to the products (0.5% and 1.2% respectively), while 99.5% of the children were positive with 100% pure milk and 97.1% was positive with processed milk. There are 1.7% of the children remained neutral to the products.

Table 4: Organoleptic difference between the two products

COLOR	N	%	P*
100% pure	186	52.7	> 0.05
ADM Gold	167	47.3	
Total	353	100	
SMELL			
100% pure	182	52.0	> 0.05
ADM Gold	168	48.0	
Total	350	97.2	
TASTE			
100% pure	185	52.4	> 0.05
ADM Gold	168	47.6	
Total	353	98.1	
FLAVOR			
100% pure	186	52.5	> 0.05
ADM Gold	168	47.5	
Total	354	98.3	
OVERALL ACCEPTANCE			
100% pure	187	52.8	> 0.05
ADM Gold	167	47.2	
Total	354	98.3	

Fisher extract test provided a p-value > 0.05 showing that there is no significant difference between the two types of milk with both being over 5 on the Hedonic scale.

Discussion

This research shows that the two commonly used milk in Vietnam including 100% pure with sugar and constituted milk with sugar when fortified with micronutrients have good acceptability among primary school children. Even though there have been organoleptic studies done on fortified micronutrients milk, most of these studies were conducted on one type of milk either pure natural liquid milk (UHT milk) or powdered milk. This organoleptic research was conducted on two types of liquid milks including pure natural milk and constituted milk and compared organoleptic qualities of these both groups. Another difference is that while other researches focus on one or several micronutrients such as iron, zinc, magnesium[13] or fortified iron[14] or fortified vitamin A and D, this research conducted on 13 different vitamins and minerals. Fortified micronutrients formula applied the WHO recommendation for home fortification of children age 6-month to 12 years (micronutrients powder). This is the first time milk was fortified with such an amount of micronutrients. An outstanding aspect of the organoleptic study on different concentrations of fortified micronutrients to satisfy different RDA is that variabilities in organoleptic acceptance only presented when minerals such as iron, magnesium and zinc reached 75% of the RDA, not when they were at 50% of RDA. Following Vietnamese regulations, fortified vitamin and minerals should reach approximately 30% of the RDA. This research confirmed that fortified dose also will affect organoleptic acceptance of the product.

An advantage of this research is the formula for fortified vitamins and minerals is developed based on the WHO recommendation for micronutrient home fortification children and guidelines for food fortification[7,15]. This research was also done on a large sample size of rural part of Vietnamese mountainous area, where children do not have regular access to the product. Therefore, when organoleptic acceptance is high, it will be more probable to integrate the programs into every day school meals using fortified micronutrients milk in Vietnam.

Conclusion

In conclusion, our research showed that fortified micronutrients 100% pure natural milk and that of constituted milk are feasible for usage for Vietnamese school children under the aspect of organoleptic acceptance to fortified micronutrients milk. However, more detail information should be provided to the parents and teachers of the students, explaining organoleptic acceptance of the product as well as research results about the effectiveness of the product consumption for general nutrition status and micronutrients status to ensure that children can consume fortified micronutrients milk regularly in a long-term period.

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