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EVALUATING THE LEVEL OF KNOWLEDGE ON ORANGE – FLESHED SWEET POTATO AND ITS BETA – CAROTENE EFFECT IN BREAD: A STUDY CONDUCTED AMONG LACTATING MOTHERS IN TAMALE METROPOLIS - GHANA

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Abstract: Food-based interventions are becoming important in approaching and addressing micronutrient deficiencies especially in lactating mothers in Ghana. Orange fleshed sweet potato (OFSP) is a good source of energy and vitamin A that has the potential of increasing vitamin A status of lactating mothers. This study assessed OFSP awareness, importance of vitamin A among lactating mothers and its contribution to β-carotene in sweet potato-based bread (Vitabutter and Vitatea) as well as estimation of vitamin A nutrient profile of the Vita bread recipes. Structured questionnaires were used to collect data in the Tamale Metropolis among lactating mothers (150). OFSP awareness among the lactating mothers was found to be low (10%). The estimated β-carotene content of the Vita bread recipes, based on earlier Vitasugar bread, would be about 2938 µg for Vitabutter and 2325 µg for Vitatea bread. This level of β-carotene content could meet (18.83-20.40% for Vitabutter and 14.90-16.15% for Vitatea) of the Recommended Dietary Allowance of vitamin A for lactating mothers, which is 1300 mcg/day. Although Vitabutter and Vitatea bread could be a food-based approach towards increasing dietary intake of vitamin A, awareness activity OFSP needs to be intensified among lactating mothers in Tamale Metropolis.

Keywords: beta carotene, sweet potato, viatmin A, lactating mothers, Nutritional deficiency, fortifications and bio – fortification.

1. INTRODUCTION

1.1. Background of study

Food-based interventions are becoming important in approaching and addressing micronutrient deficiencies. Examples include orange-fleshed sweet potato (OFSP) and orange maize as dietary sources of provitamin A, high iron and zinc bean and iron biofortified pearl millet as dietary sources of iron and zinc. Biologically, β-carotene is an important precursor of vitamin A, which has an anti-oxidant property and may help in the prevention of cancer and other diseases (Cancer Council Australia, 2009). Research suggests that, dietary intake of foods high in β-carotene have positive associations with decreased risk of cardio-vascular diseases as well as oral cavity and lung cancer (Cancer Council Australia, 2009; Dalmiya & Palmer, 2007).

β-carotene is a provitamin A molecule that gives certain vegetables and food matters their orange color (Rao & Rao, 2007) . It is part of a family of chemicals called carotenoids that are found in many fruits and vegetables, and animal products inclusively egg yolk (WHO, 1998).

Actions are being taken by government, private organizations and non-governmental organizations (NGOs) to improve vitamin A intake through dietary consumption of foods rich vitamin A. An example is the HarvestPlus initiative to breed and disseminate OFSP roots (vitamin A precursor) to improve nutrition and public

health (HarvestPlus, 2012). Another example is the fortification of vegetable oil by the Ghana government (Nyumuah et al., 2012).

Sweet potato is the seventh most important food crop after rice, wheat, potatoes, maize, yam and cassava (G. Loebenstein, 2009).

It was one of the top five food items produced in 2013 (FAOSTAT, 2014). Depending on the flesh color, sweetpotato roots are rich in β-carotene, anthocyanins, total phenolic, dietary fiber, ascorbic acid, folic acid and minerals (Truong & Avula, 2010). Of interest in this study is the varieties with orange color of the flesh of the roots known as the OFSP.

OFSP has been identified to have a great likelihood of improving vitamin A status among individuals especially lactating mothers who for the most part are at high risk of VAD (Low *et al.*, 2007). It is a vital source of energy and β-carotene as reported by Low *et al.* (2000), which is converted into vitamin A in the body.

In Ghana, consumption of bread is increasing as reported by Komlaga *et al.* (2012), and efforts to use puree in bread production is getting attention (Bonsi *et al.*, 2014; Osabutey, 2015). Bonsi *et al*. (2014) reported that bread is a major staple in Ghana for both young and old, and it takes the highest cash expenditure within the food sub-group. In this study, the awareness of OFSP among lactating mothers, the group with the highest Recommended Dietary Allowance for vitamin A (1200-1300 µg/day), was assessed. Also the weighed food intake of two OFSP-based bread types (Vitabutter and Vitatea) was determined among lactating mothers and was used to estimate the intake of vitamin A for both Vitabutter and Vitatea bread.

1.2. Problem Statement

VAD has become a major health issue affecting almost every individual especially lactating woman whose demand for vitamin A is high. The high prevalence of VAD among mothers and children in Ghana has prompted the search for actions to combat the deficiency. These actions are being taken by the government, private organizations and non-governmental organizations (NGOs) to improve vitamin A intake through dietary consumption of foods rich in vitamin A. Combatting this problem among these vulnerable group, will help decrease mortality and morbidity (Strang, 2009).

1.3. Justification

OFSP has an exciting possible contribution to the human diet around the world (Truong & Avula, 2010) and improving vitamin A status (Gikunda, 2015). On the other hand, bread is commonly consumed by Ghanaians daily, and is a main staple food taking the maximum cash expenditure within the food sub-groups (Bonsi *et al*., 2014), but it made from 100% wheat flour that is fortified (Nyumuah *et al.*, 2012). However, research on OFSP as an ingredient for bread indicates that the vitamin A content in 100% wheat flour-bread was negligible (0.26 mcg/100 g) (Amagloh *et al.*, 2015).

With the high consumption of bread in Ghana, and the development of two new OFSP-based bread recipes, denoted Vitabutter and Vitatea, as part of the ongoing research on OFSP puree inclusion in bread in Ghana, there is the need to assess the intake of bread and it use it to estimate the vitamin A profile of these new recipes. Also, knowledge of OFSP among lactating mothers is warranted, as they are several NGOs working particularly in Northern Region, on the promotion and utilization of OFSP for wealth and health.

1.4. Research Objectives

1. To evaluaute the knowledge of OFSP among lactating mothers in Tamale Metropolis.
2. To determine OFSP contribution to β-carotene in sweetpotato-based bread.
3. To determine the percentage of daily reference intake of vitamin A by consumption of sweetpotato-based bread of lactating mothers.

2. LITERATURE REVIEW

2.1. Importance of vitamin A

Vitamin A is an essential nutrient needed in small amounts for healthy growth, immunity, and reproduction (Clagett-Dame & Knutson, 2011; Kumar, 2010). They are vital components of good nutrition and human health, advancing physical and intellectual development in many important ways. Vitamin A also supports cell growth and differentiation, playing a critical role in the normal formation and maintenance of the heart, lungs, kidneys, and other organs (National Institutes of Health, 2016) .

Two forms of vitamin A, are available in the human diet, namely retinol with its esterified form and retinyl ester and provitamin A carotenoids. Retinol is found in foods with animal origin, including dairy products, fish, and meat (especially liver). The most important provitamin A carotenoid is β-carotene; other provitamin A carotenoids are alpha-carotene and beta-kryptoxanthin. The body converts these plant pigments into vitamin A (WHO, 2012). Both provitamin A and preformed vitamin A must be metabolized intracellularly to retinal and retinoic acid, the active forms of vitamin A, to support the vitamin's important biological functions (National Institutes of Health, 2016).

Lack of this vitamins result into so many conditions such as blindness, growth limitations, weakened defenses, susceptibility to infection, and increased mortality, at large called VAD.

This micronutrient deficiency, also known as hidden hunger, does not only prevents people from surviving and thriving as productive members of society, but also holds countries back in a cycle of poor nutrition, poor health, lost productivity, persistent poverty, and reduced economic growth (Kurabachew, 2015). VAD is a major contributor when it comes to mortality and mobility rates among individuals especially children under five (WHO, 2012).

The delivery of high-dose supplements remains the principal strategy for controlling VAD. Biofortification, food fortification and consumption of foods rich in vitamin A as well as nutrition education are becoming increasingly feasible but have not yet ensured coverage levels similar to supplementation in most affected areas (UNICEF, 2007).

2.2. Sweet potato and its Importance

Sweet potato ranks the seventh most vital food crop in the world and fourth in tropical countries (FAOSTAT, 2004). In comparison to other major staple food crops, sweet potato has the following positive characteristics: wide production geography, flexibility to marginal condition, short production cycle, high nutritional value and sensory versatility in terms of flesh colors, taste and texture. The β-carotene content of sweetpotato roots differs greatly.

Depending on the flesh color, sweetpotatoes are high in β-carotene, anthocyanin, total phenolic, dietary fiber, ascorbic acid, folic acid and minerals (Avula, 2010).

The OFSP (*Ipomoea batatas [L.] Lam.*) cultivar is known as one of nature's unsurpassed sources of β-carotene, among other health benefits, with a content as high as 6495 µg/100 g (Bonsi *et al*., 2014). The orange color of OFSP has an association with β-carotene content (Low *et al.*, 2015)

The introduction of OFSP is a unique food-based approach that has great possibility of decreasing VAD (Jenkins *et al*., 2015). Though most varieties of sweetpotato usually grown in sub-Saharan Africa are white-fleshed and deficient in vitamin A, OFSP offers high levels of this vital micronutrient and is drought resistant and cultivated easily (Jenkins *et al.*, 2015).

2.3. Reason for the Fortification of Bread with OFSP

OFSP is a naturally bio-fortified crop and has great potential of being used in food-based intervention programs to address VAD. Throughout sub-Saharan Africa, sweet potato roots are mostly eaten as an accompanying staple food (Wheatley & Loechl, 2008). The crop is a promising resolution to VAD. It is high in β-carotene and greatly absorbed better than its leaves and vegetables (Kurabachew, 2015). OFSP appears to be an upcoming effective measure for increasing the vitamin A status (Low *et al*., 2007). Low *et al.* (2007) reported that, a rise in vitamin A intake with consumption of OFSP and an accompanying increase in serum retinol concentrations.

Bread is commonly consumed by Ghanaians daily, and is a main staple food taking the maximum cash expenditure within the food sub-groups (Bonsi *et al*., 2014). Food fortification is believed to be more effective when staples foods are used as vehicles (Bonsi *et al*., 2014). Kidane *et al*., (2013) produced flat bread with 30% orange-fleshed sweet potato flour and stated that it could meet 61%-86% daily needs of children 3-6 years of age. Hence, the need to process more food-based OFSP meals. This also encourages the promotion and production of OFSP cultivars by farmers, as well as provide a food-based fortification program that can help combat the high prevalence of VAD in Ghana, and most lower-middle income countries (Bonsi *et al.*, 2014).

2.4. Prevalence of VAD in lactating mothers

The nutritional status of mothers is a vital factor both prenatally and after birth. Prenatal maternal nutritional status affects baby's birth weight, neonatal morbidity and mortality, and the micronutrient status. Postnatal maternal status can affect the quality of breast milk and the nutrient consumption of infants (Dijkhuizen *et al.*, 2001). Absorptions of hemoglobin, plasma retinol, plasma β-carotene, and plasma zinc are all strongly linked between the mother-infant pairs.

Concentrations of vitamin A in breast milk are said to be closely related to those in the plasma of the infants, with breast milk being a key connecting link, especially for vitamin A nutrition (Dijkhuizen *et al.*, 2001).

VAD is a key nutritional concern in poor societies, especially in lower income countries with the most vulnerable being mothers especially during lactation (WHO, 2011b). This situation, is a major public health problem among World Health Organization (WHO) regions in Africa and South-East Asia (WHO, 2011b).

In areas where VAD is common, mothers may produce breast milk with lower concentrations of vitamin A (Newman, 1993). However, if a mother cannot meet the increased vitamin A requirements during lactation through the diet, her body will attempt to compensate for the low levels of vitamin A in the breast milk by drawing on the vitamin A reserves in the liver (Allen & Haskell, 2001).

The main underlying cause of VAD as a public health problem is a diet that is constantly insufficient in vitamin A and failure to absorb vitamin A during digestion due to poor health (WHO, 2011a). This can lead to lower body stores and failure to meet physiologic needs (WHO, 2009). VAD affect metabolism and immune function and contribute to the development of anemia and stunting (Dijkhuizen et al., 2001).

Programs such as postpartum supplementation, dietary diversification and food fortification with vitamin A have been used to improve mothers' vitamin A status and to increase the vitamin A content of breast milk (Stoltzfus & Humphrey, 2002).

This protects the vitamin A reserves of lactating mothers while addressing the problem of low intakes of vitamin A from breast milk in infants (Miller *et al.*, 2002). Food-based approaches such as using OFSP for bread may help contribute to the Dietary Recommended Intake for vitamin A in lactating mothers.

3. METHODOLOGY

3.1. Source of bread

Two OFSP-based bread types, Vitabutter and Vitatea, were sourced from Pakrozy bakery, Tamale. The sizes used were 300, 400 and 500 g for the Vitatea bread and 400, 500 and 600 g for the Vitabutter bread.

3.2. Population

The target population used for this study were lactating mothers within the ages of 15-49 years in Tamale Metropolis. It involved lactating mothers from all walks of life including religion and ethnicity.

A sample size of 150 lactating mothers was selected from the total population for this project. With this project, 50 of the lactating mothers participated in the dietary consumption assessment and 100 participated in the awareness assessment.

3.3. Research Design

Cross sectional design was used to collect vitamin A intake data from 50 lactating mothers, and also assess the awareness of OFSP and the importance of vitamin A among 100 lactating mothers in the Tamale Metropolis, Northern Region.

3.4. Awareness of OFSP and importance of vitamin A

Structured questionnaires were used to collect data on the awareness of OFSP and importance of vitamin A among 100 lactating mothers at three (3) different locations (Central, West and Tamale Teaching hospitals) in Tamale Metropolis, Northern Region.

3.5. Bread Intake by lactating mothers

Permission was sought from the Assemblyman and Imam of selected study area, Dungu in Tamale Metropolitan District, Northern Region to collect data. Purposive sampling was used to reach respondents to collect data from them and this was done with the help of translators. The two OFSP-based bread types were

weighed before given to the lactating mothers. Portions of bread left after the consumption of the amount supplied were also weighed again to get the actual bread intake. The means of bread intake for Vitabutter and Vitatea were calculated from the intake data.

3.6. Estimation of Dietary intake of vitamin A by lactating mothers

Simple proportion was used to estimate the dietary intake of vitamin A based on previous study by Osabutey (2015). According to Osabutey (2015), 100 g of sugar Vita bread provides 1189 µg of β-carotene. It was upon this estimation that the vitamin A intake in Vitabutter and Vitatea were calculated.

3.7. Data Analysis

The data collected were analyzed with the Microsoft excel 2010 and the results were presented in tables, chats and figures.

4. RESULTS

4.1. Introduction

This chapter contains results of the current study as derived from the baking, dietary assessment and data analysis. The presentation of the results is based on the headings carved in the objectives.

4.2. Demographic Data

Table 4.1: Age Distribution of lactating mothers (n=150)

Age Distribution	Frequency
15-25	82
26-35	53
36-49	15
Total	150

The age distribution of lactating mothers is presented in Table 4.1 above. The lactating mothers of ages 15-25 years were 82 out of the 150 lactating mothers we interviewed. At the ages 36-49, the lactating mothers were few (15).

4.2 Importance of vitamin A among lactating mothers

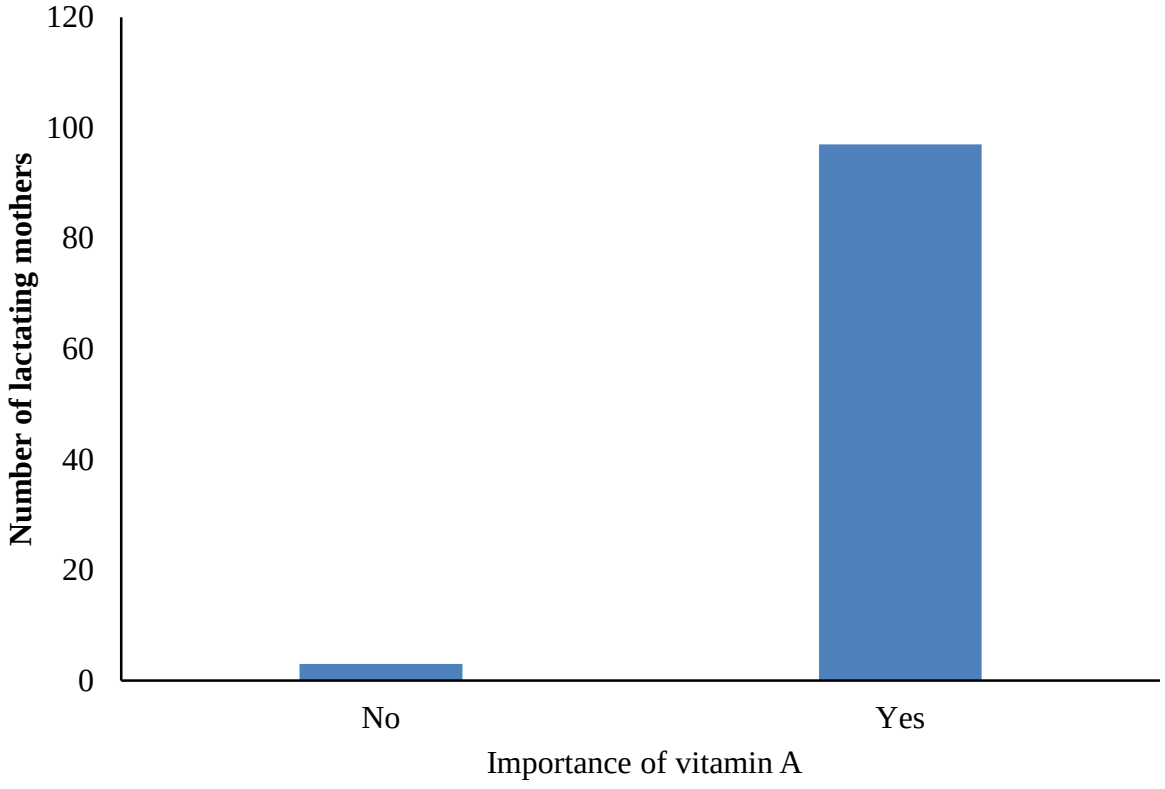

Figure 4.1: Importance of vitamin A among lactating mothers

The results from the data collected on the importance of vitamin A among lactating mothers is presented in Figure 4.1. The result showed that majority of the lactating mothers (98%) knew the importance of vitamin A.

4.3 Awareness of OFSP among lactating mothers

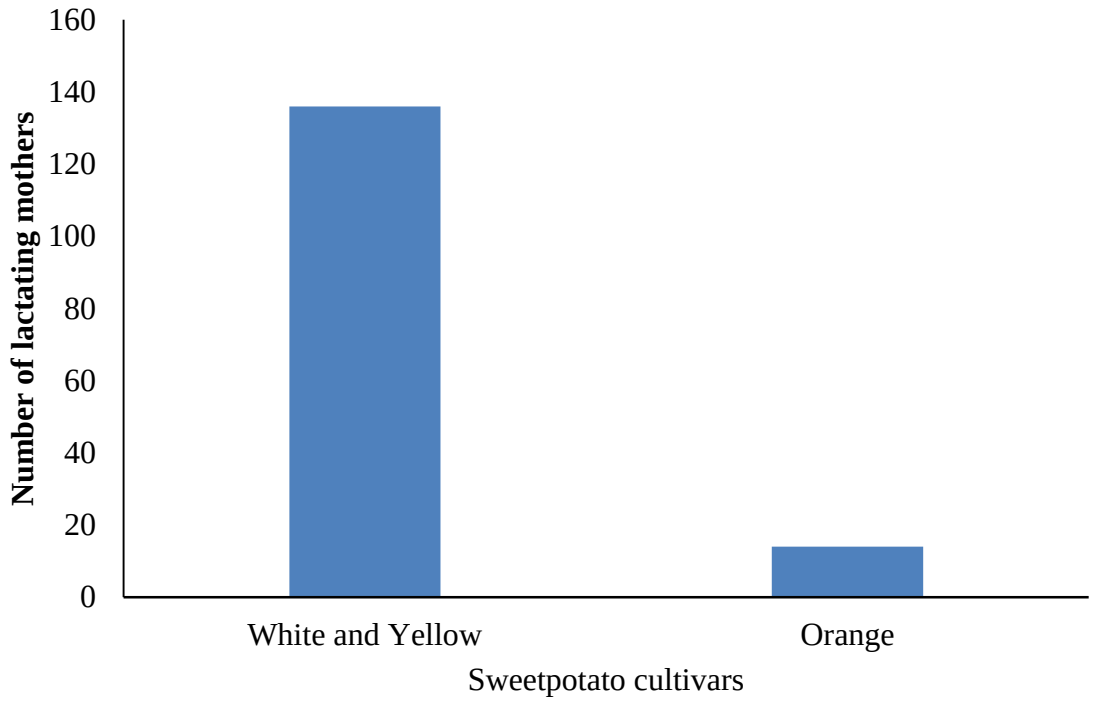

Figure 4.2: Awareness of OFSP among lactating mothers

Figure 4.2 above represents the results from the data collected on the awareness of sweetpotato cultivars among the lactating mothers. Out of the 100 lactating mothers interviewed, only 10% of them were aware of OFSP.

4.4 Dietary intake of vitamin A by 50 lactating mothers from their consumption of OFSP-based bread types

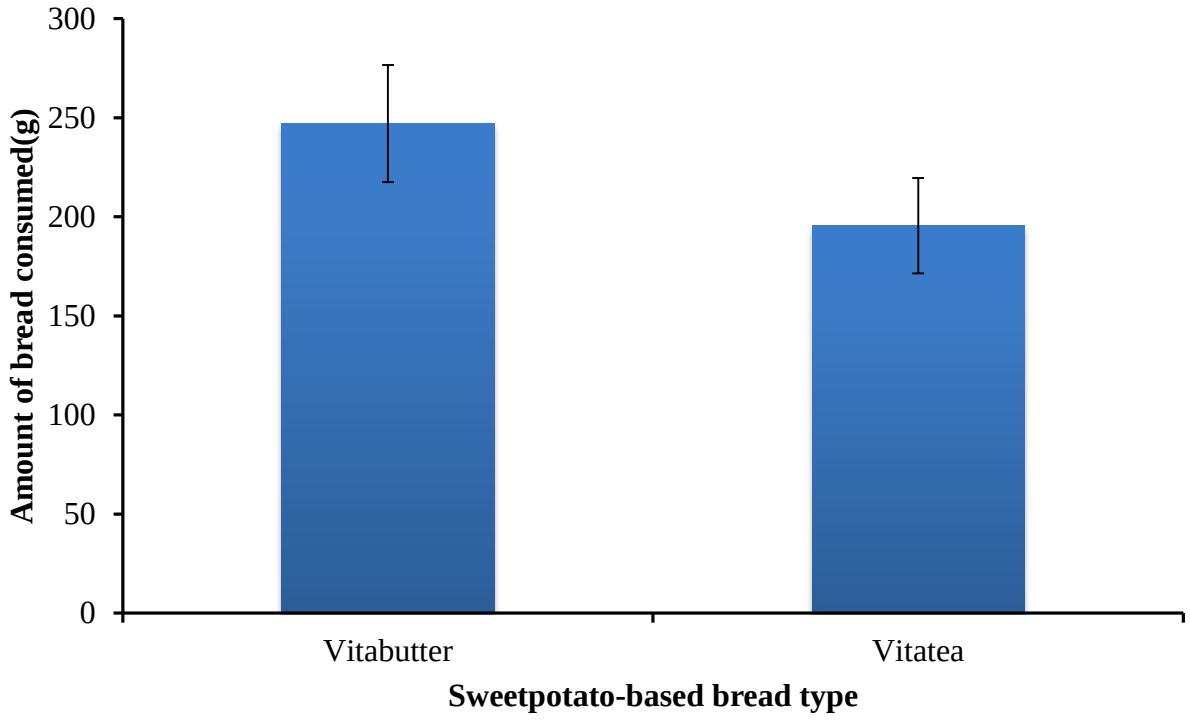

Figure 4.3: Mean of the dietary intake of sweetpotato-based bread by lactating mothers

Bars are mean intake ± standard deviations

From the results of the mean intake of bread by lactating mothers, the mean of the Vitabutter and Vitatea were 247.1 g and 195.6 g respectively, but it was not significantly different (p=0.18)

4.5 β-carotene content of Vitabutter and Vitatea bread on means of bread intake.

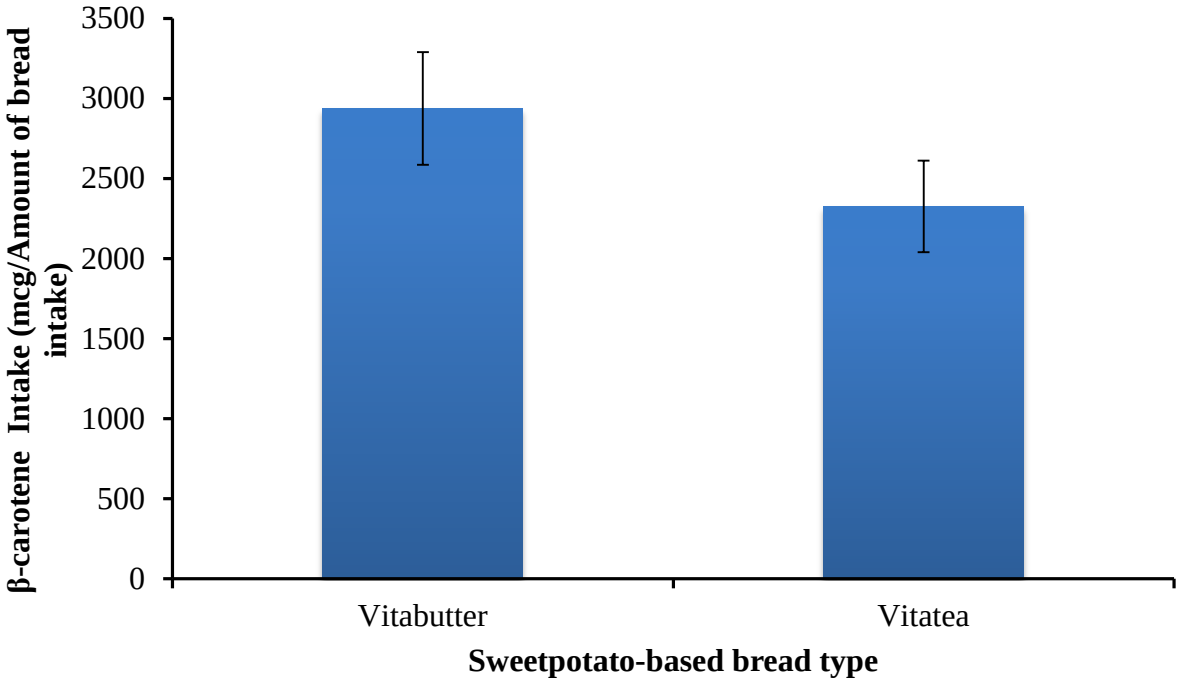

Figure 4.4: β-carotene content of sweetpotato bread based on means of bread intake

Bars are mean intake ± standard deviations

Figure 4.4 represents the β-carotene contents of Vitabutter and Vitatea bread on means of bread intake. From the results, the β-carotene of Vitabutter bread was 2938 µg and Vitatea bread was 2325 µg.

4.6 Vitamin A content of Vitabutter and Vitatea bread with respect to the average means of bread types intake

Table 4.2: Vitamin A content with respect to the average means of bread types intake

Age of lactating mothers	Vitamin A requirement (mcg/day)	OFSP-based bread estimated vitamin A (mcg/day)	
		Vita butter	Vita tea
14-18 years	1200	20.40%	16.15%
19-50 years	1300	18.83%	14.90%

β-carotene was converted to RAE µg/day using 1RAE= 12 µg β-carotene

Vitamin A content with respect to the average means of bread type intake by lactating mothers is presented in Table 4.2 above. Analysis was based on previous β-carotene content of 1189 µg/100g in sugar Vita bread (Osabutey, 2015).

5. Discussion

5.1. OFSP awareness among lactating mothers

The low awareness of OFSP among the lactating mothers could be due to the reason that majority of the farmers in Ghana cultivate the white and yellow cultivars.

5.2. Importance of vitamin A by lactating mothers

The awareness of the importance of vitamin A was high among the lactating mothers. This could be due to the nutrition education they receive at the various health facilities they visit, from close relations, seminars or social media.

5.3. OFSP contribution to β-carotene in sweetpotato-based bread

The OFSP contribution of β-carotene in Vitabutter bread was 2938 µg/100 g and 2325 µg/100 g in Vitatea bread as compared to white bread which was reported to be 0.26 µg/100 g by Amagloh *et al.*, (2015). This shows that the OFSP-based bread would contribute to the higher intake of vitamin A in Ghana than the white bread.

5.4. Percentage of daily reference intake of vitamin A by consumption of sweetpotato-based bread of lactating mothers.

OFSP-based bread types were found to contribute higher amounts of vitamin A to the Dietary Reference Intake of lactating mothers especially those within the age range of 15-25 years. This could

mean that most of them would get higher percentage of their daily allowance of vitamin A if they continuously consume the bread. Also, the intake of both Vitabutter and Vitatea bread were twice the recommended serving size of bread of 104 g for adults.

Since, bread is becoming a major staple in Ghana, Vita bread types could be described as good sources of vitamin A for lactating mothers (14-49 years) as they met 15-20% Recommended Dietary Allowance for this essential nutrient. This supports the findings of HarvestPlus, (2012) which reported that the consumption of OFSP met the required daily vitamin A consumption of mothers in Mozambique and Uganda.

Kurabachew, (2015) wrote as confirmation to poor dietary habits and the dependency on cereals coupled with poverty, does not allow majority to get vitamin A rich foods. The findings of this study suggest the need to promote food diversification and also refinement of existing food recipes to incorporate biofortified food crops to increase the dietary intake of some essential micronutrients. In this regard, OFSP is naturally rich in β-carotene and excellent food source of provitamin A. This crop can be used for the long-term and sustainable food-based intervention to prevent VAD.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The level of awareness of OFSP was low among lactating mothers. OFSP-based bread will contribute significant amount of vitamin A in the diet of lactating mothers in the Tamale Metropolis, and possibly Ghana as a whole. Consumption of Vitabutter and Vitatea bread could be a food-based approach towards increasing dietary intake of vitamin A being advocated as an indicator for the long-term measure for combating vitamin A deficiency.

6.2. Recommendations

Partnership with private sector for effective commercialization of formulated products especially products from the OFSP roots would be of great help in Ghana to help reduce vitamin A deficiency.

Vitamin A awareness should be done nationwide; the rural communities should be for primary focus through the use of food items and crops such as OFSP.

Local markets and small scale processing industries should get involved in the production of healthy dietary innovations using OFSP.

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