

ACCEPTABILITY OF A CALCIUM FORTIFIED THAI ETHNIC SNACK, KHAO LAM

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Abstract

A high prevalence of bone diseases have been reported in many countries and inadequate intake of calcium is recognized as one of the main factors leading to decreased bone density. Calcium fortification is proven as an effective method used to increase calcium consumption. This study aimed to develop Khao Lam, steamed sticky rice in bamboo, a traditional snack in Chonburi, Thailand. This snack is familiar to the local population, is based on Thai tradition and culture, so is a good candidate to test calcium fortification. Three Khao Lam formulas recipes were developed (original formula recipe, calcium carbonate fortified formula recipe, and tricalcium phosphate fortified formula recipe) to determine participants' satisfaction regarding appearance, taste, flavor, color, texture, and overall satisfaction, measured using sensory evaluation methods. The findings of this study revealed no significant differences in all aspects of the 3 recipes, except that the texture of the tricalcium phosphate preparation had a lower than average satisfaction score when compared with the original formula and the calcium carbonate formula recipe. In addition, results indicated that original formula and the calcium carbonate fortified recipe had satisfaction scores equally acceptable to all participants. In conclusion, the developed Khao Lam with calcium carbonate fortification is acceptable to participants.

Keywords: Khao Lam, Thai ethnic snack, calcium, food fortification, sensory evaluation

Introduction

Reduced density of bone mass is one of the commonly found health problems that leads to many complications, such as osteoporosis and bone fracture, which reduces the quality of life (Cranney *et al.*, 2007; Madureira *et al.*, 2012). A high prevalence of osteoporosis has been reported in many countries, as demonstrated in a previous study in the United States. This study revealed that 44% of older adults suffered from low bone mass density

and 7.7 million non-Hispanic White, 0.5 million non-Hispanic Black, and 0.6 million Mexican American adults had osteoporosis (Wright *et al.*, 2014). Another similar study indicated 46 million of older women in India had osteoporosis (Khadilkar and Mandlik, 2015). In Thailand, the high prevalence of osteoporosis among Thai people has resulted in high fracture rates; an incidence of 12.6%, 4.6%, and 3.9% at the femoral neck, lumbar spine and both

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sites, respectively among Thai men (Pongchaiyakul *et al.*, 2006) and 5.5% and 6.3% at the lumbar spine and hip, respectively among Thai women (Pongchaiyakul and Kotruchin, 2013). It is well known that long-term lack of intake of food sources of calcium, such as milk and milk products, is the cause of the calcium deficiency. A previous study revealed that the average amount of daily calcium consumption among Thai adults is 378.6 mg in men and 265.6 mg in women (Pongchaiyakul *et al.*, 2008) which does not meet the accepted dietary guidelines of 1,000 mg per day of calcium requirement for adults (Hunt and Johnson, 2007). Therefore, provision of adequate calcium intake among Thai people could be an effective way to reduce the risk of the development of low-density bone pathology (Sunycz, 2008). Nowadays, many food products have been developed with calcium fortification to act as alternative food sources of calcium to promote calcium consumption. For example, calcium fortified ice cream and calcium fortified cereal bars have been developed to promote calcium consumption (Lee *et al.*, 2015; van der Hee *et al.*, 2009).

Khao Lam (steamed sticky rice in bamboo) is a traditional snack widely found in South East Asia. This is one of the most famous snacks in Chonburi, an oceanside province located in the east of Thailand. There are a variety of recipes, area dependent, handed down by generations of local people, living in the Nongmon market, Bangsaen subdistrict, Chonburi, and these snacks are usually bought by the tourists and visitors as gifts. The ingredients and cooking method of Khao Lam in Nongmon market, Bangsaen subdistrict, Chonburi, consists of sticky rice, red bean, coconut milk, and sugar which is placed in hollow bamboo and then steamed. Due to the location of many industries and factories, many famous festivals, and many tourist attractions it provides an ideal economy of scale province in which to conduct this research (Mieno, 2013). According to the database on inadequate calcium among Thai people and the development of calcium fortified snacks, to promote calcium intake, have indicated that foods more familiar to people according to their traditions and background, is



Figure 1. Overview in cooking methods of Khao Lam

a key factor affecting their satisfaction and acceptance of developed food products (Roudsari *et al.*, 2017). Nowadays, there is a lack of development of Thai ethnic snacks which are familiar to Thai people, that could help with calcium fortification to promote calcium intake. This study, therefore, aimed to develop the calcium fortified-Khao Lam which is the local snack of the Nongmon market, Bangsaen subdistrict, Chonburi.

Materials and Methods

Development of the Calcium Fortified-Khao Lam

The preparation of the Khao Lam was conducted at the Clinical Nutrition Laboratory, Faculty of Allied Health Sciences, Burapha University, Bangsaen Campus, Chonburi. Three formula recipes of Khao Lam, original formula (OGF), calcium carbonate-fortified formula (CCF), and tricalcium phosphate fortified-formula (TPF), were developed to be the food samples for this study adapted from the Thai traditional snack handbook (Phayomyong, 1999). All formulas had identical amounts of the main ingredients and cooking methods were likewise controlled to prevent confounding factors. For the CCF and TPF recipes, the amount of calcium to be added to the fortified food samples was identical in that 25% of the daily calcium requirement was provided per serving, according to the food guidelines. The amount of calcium carbonate and tricalcium phosphate added to the calcium fortified-formula was calculated by the calcium/carbonate ratio and tricalcium/phosphate ratio respectively, as shown in the nutritional data sheets of the commercially obtained calcium carbonate and tricalcium phosphate powder packaging (Figure 1). The total energy and energy distribution per serving size was calculated using the nutritional software package (INMUCAL-Nutrients version 1.5) developed by the Institute of Nutrition, Mahidol University.

Development of the Sensory Evaluation Questionnaire

A nine point-hedonic scale questionnaire was developed to rate the participants satisfaction towards the developed calcium fortified-Khao Lam formulas, compared with the original formula, using sensory evaluation (Figure 2). The questionnaire



Figure 2. Nine-point hedonic scale

was a validated facial scale questionnaire, adapted from a previous study, that was used to rate participants satisfaction on appearance, taste, flavor, color, texture, and overall satisfaction of the developed food samples. The numerical scoring was as follows. Terrible = 1 point, Very bad = 2 points, Bad = 3 points, Just a little bad = 4 points, Maybe good or may be bad = 5 points, Just a little good = 6 points, Good = 7 points, Very good = 8 points, and Great = 9 points. Test samples, with an average score of overall satisfaction above 8, were classified as “acceptable”, those with an average score of overall satisfaction between 5 and 7 were classified as “passive”, and those with an average score on overall satisfaction below 5 were classified as “rejected” (Manickavasagan *et al.*, 2016).

The developed sensory evaluation questionnaire was reviewed and commented on by experts in nutrition at the Institute of Nutrition, Mahidol University. After that, the revised questionnaire and study protocol of this study were submitted to the Burapha University Institutional Review Board (BUU-IRB) for ethical approval (approval code number 6200/00963). Once completed, the approved developed sensory evaluation questionnaire was pre-tested among 12 participants from similar backgrounds and evaluated with an intervention group for their review and understanding (Hertzog, 2008).

Sample Selection

This was experimental study investigated in participants living in Tambon Sansook area, Chonburi. After enrollment, thirty healthy participants, both male and female, were conveniently recruited to participate in this study by the calculation using the equation for t-test formula (one sample) with the following inclusion criteria: age between 20-60 years, have no any oral problems effect on their chewing, swallowing, and food perception, able to read and write Thai, and willing to participate in this study. Exclusion criteria included participants with a medical history of food allergy, participants with a medical history of mental disorder, limited food intake due to religion and culture, not completing questionnaire, and not able to participate throughout the study. The total number of participants in this study was comparable to previous study which studied the sensory evaluation for the developed food products (Singhato *et al.*, 2019).

Study Procedure

Once the participants, who met the inclusion and exclusion criteria, received information about the study protocol, they were invited to the Clinical Nutrition Laboratory, Faculty of Allied Health Sciences, Burapa University to sign informed

consent forms before participating in this study. After that, participants were asked to conduct the sensory evaluation to determine their satisfaction on appearance, taste, flavor, color, texture, and overall satisfaction toward the 3 developed Khao Lam formulas. The blinded samples of the Khao Lam formulas (OGF, CBF, and TPF) were served to each participant. Samples were presented with water and paper ballots on a plastic tray. Participants were asked to eat the whole sample and then rinse their mouths with water in-between the tastings to minimize any residual taste.

Statistical Analysis

Satisfaction scores on appearance, taste, flavor, color, texture, and overall satisfaction were reported as mean and standard deviation (SD). One-way ANOVA was used to compare the means of the satisfaction scores between the OGF, CBF, and TPF formulas. Dependent paired t-test was used to compare the means of the satisfaction scores between OGF and CBF formulas, OGF and TPF formulas, and CBF and TPF formulas. Statistical analyses were performed using the predictive analytics software statistics (PASW) version 21.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was established at $p < 0.05$.

Results and Discussion

Most of participants in this study were female ($n = 20$). The average age and body mass index of the participants were 22.53 (± 1.73) and 22.13 (± 2.38), respectively. All participants were both undergraduate and graduate students in the university (data not shown in the table).

Amount of Energy and Calcium Per Serving Size

The energy provided by all 3 Khao Lam formula recipes was measured at 540 kcal per serving size. Also, the energy distribution of all 3 Khao Lam formula recipes was the same, with energy derived from carbohydrate at 30%, from protein 4%, and from fat 66%. In addition, the estimated amount of calcium obtained in Khao Lam with the OGF recipe was 16 mg per serving size, whilst the estimated amount of calcium obtained in Khao Lam with the OGF and CBF recipes was 266 mg per serving size.

Sensory Evaluation Scores

The participants' satisfaction scores indicated that there were no significant differences in all aspects of the 3 formulas, except for texture results that revealed a significant difference in satisfaction scores. In addition, results revealed that the

developed Khao Lam with OGF and CBF recipes had average overall satisfaction scores, measured as acceptable, to participants (Table 1).

Comparison between OGF and CBF recipes, revealed that there were no significant differences in the participants' satisfaction scores in all aspects (Table 2).

Comparison between the OGF and TPF recipes revealed that there were no significant differences in the participants' satisfaction scores in all aspects, except for texture. The TPF score in this regard was significantly lower than the OGF recipe (Table 3).

Comparison between the CBF and TPF recipes revealed that there were no significant differences in the participants' satisfaction scores in all aspects,

except that the texture score of the TPF was significantly lower than the CBF recipe (Table 4).

Presently there are many studies aiming to promote improved calcium intake, by development of a variety of food products, based on traditional and cultural backgrounds. For example, development of calcium fortified-puffed rice extrudates and rice noodles (Janve and Singhal, 2018) and the development of calcium fortified-blue maize flours (Sánchez-Madrigal *et al.*, 2015), have generated alternative food products with calcium fortification. The findings of this study showed participants' satisfaction with the developed calcium fortified-Thai ethnic snack recipe, Khao Lam with CBF. However, the Khao Lam with TPF recipe had an average overall satisfaction score not meeting the

Table 1. Comparison of the participants' satisfaction scores of the 3 Khao Lam recipes

Aspects	OGF	CBF	TPF	F	p-value
	Mean (SD)	Mean (SD)	Mean (SD)		
Appearance	8.23 (1.04)	8.13 (0.77)	8.06 (0.90)	0.25	0.77
Taste	8.20 (0.99)	8.16 (0.79)	7.93 (0.86)	0.80	0.45
Flavor	7.73 (1.20)	7.43 (1.61)	7.53 (1.50)	0.33	0.71
Color	8.13 (0.77)	8.03 (1.06)	7.96 (1.03)	0.22	0.79
Texture	7.90 (0.99)	7.86 (1.07)	7.06 (1.63)	4.14	0.01*
Overall satisfaction	8.06 (1.33)	8.03 (0.92)	7.86 (0.86)	0.30	0.73

One-way ANOVA with 95% confidence interval. / Total score = 9 / * Significant difference

Table 2. Comparison of the participants' satisfaction scores between OGF and CBF recipes

Aspects	OGF	CBF	p-value
	Mean (SD)	Mean (SD)	
Appearance	8.23 (1.04)	8.13 (0.77)	0.64
Taste	8.20 (0.99)	8.16 (0.79)	0.89
Flavor	7.73 (1.20)	7.43 (1.61)	0.35
Color	8.13 (0.77)	8.03 (1.06)	0.66
Texture	7.90 (0.99)	7.86 (1.07)	0.87
Overall satisfaction	8.06 (1.33)	8.03 (0.92)	0.90

Dependent paired t-test with 95% confidence interval. / Total score = 9

Table 3. Comparison of the participants' satisfaction scores between OGF and TPF recipes

Aspects	OGF	TPF	p-value
	Mean (SD)	Mean (SD)	
Appearance	8.23 (1.04)	8.06 (0.90)	0.49
Taste	8.20 (0.99)	7.93 (0.86)	0.28
Flavor	7.73 (1.20)	7.53 (1.50)	0.60
Color	8.13 (0.77)	7.96 (1.03)	0.25
Texture	7.90 (0.99)	7.06 (1.63)	0.01*
Overall satisfaction	8.06 (1.33)	7.86 (0.86)	0.47

Dependent paired t-test with 95% confidence interval. / Total score = 9 / * Significant difference

Table 4. Comparison of the participants' satisfaction scores between CBF and TPF recipes

Aspects	CBF	TPF	p-value
	Mean (SD)	Mean (SD)	
Appearance	8.13 (0.77)	8.06 (0.90)	0.75
Taste	8.16 (0.79)	7.93 (0.86)	0.18
Flavor	7.43 (1.61)	7.53 (1.50)	0.81
Color	8.03 (1.06)	7.96 (1.03)	0.78
Texture	7.86 (1.07)	7.06 (1.63)	0.02*
Overall satisfaction	8.03 (0.92)	7.86 (0.86)	0.43

Dependent paired t-test with 95% confidence interval. / Total score = 9 / * Significant difference

acceptable level. Additionally our results showed significant differences of average scores relating to texture of the TPF recipe that were lower when compared to the OGF and CBF recipes. These results are similar to a previous study, using calcium phosphate fortified yogurt (Ozcan *et al.*, 2011), found that the amount of phosphate contained in food had an adverse effect on the quality and texture of the food. Another similar previous study demonstrated that the use of tricalcium phosphate reduced the quality and texture of developed bakery products (Nemati *et al.*, 2015). In addition, previous study pointed out the different oral physiological characteristics included individual chewing behavior regardless of the temporal aspects of dominant processes of comminution, insalivation, bolus formation and swallowing could be factors on texture attributes and taste perception (Liu *et al.*, 2017), the participants in this study were not reported on oral processing problem by the study criteria recruitment to minimize these interfering factors. Importantly another previous study revealed that the high effectiveness and bioavailability of calcium carbonate (Wang *et al.*, 2014), and tricalcium phosphate, resulted in high phosphate content in food products, these should be avoided in patients with chronic kidney disease (CKD), who have a high risk of developing hyperphosphatemia, due to decreased renal phosphate excretion (Ritter and Slatopolsky, 2016). These patients require other forms of calcium supplementation. Taken as a whole these results suggest that calcium carbonate fortification of specified food products would be appropriate to improve calcium consumption among healthy people and patients with non-communicable diseases.

Guidelines on optimal daily calcium consumption among adults is agreed to be a level of 1,000 mg per day (Uusi-Rasi *et al.*, 2013). The fortified Khao Lam provides 25% of the total daily calcium requirement. However, achieving the daily total calcium intake using the developed Khao Lam with CBF recipe is not to be recommended because of its high sugar and fat content, derived from the sugar and coconut milk in the traditional recipe. Therefore, further studies are possibly needed, to improve the recipes using artificial sweeteners and low-fat coconut milk, which would be more appropriate for people with metabolic syndrome (Brown *et al.*, 2010; Ekanayaka *et al.*, 2013). This, however has an inherent risk of the food being perceived as processed and not organic or natural. This study was limited in that only a single level of calcium fortification was used in the Khao Lam. Therefore, further studies are needed to investigate the participants' satisfaction using differing higher amounts of calcium in fortified

Khao Lam as well further investigation on proximate analysis such as crude fiber, moisture content, ash determination, color measuring, etc. using the food science laboratory instruments to improve the quality of the developed calcium fortified Khao Lam. In addition, developed Khao Lam with CBF recipes should be used in randomized controlled trials, to observe long term daily calcium consumption and measurable and improved bone health outcomes.

Conclusions

In conclusion, the developed Khao Lam with CBF recipe is acceptable to participants and is a valid start point for further investigation.

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