



Acceptability of a High Protein Snack Using Artificial Sweeteners for People Living with HIV with Oral Problems

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Abstract

People living with HIV (PLHIV) with oral problems usually suffer from malnutrition due to difficulties in chewing and swallowing, which lead to undernutrition. In addition, hyperglycemia is one of the major problems among PLHIV receiving antiretroviral therapy (ART). Up to now, in Thailand there is still a lack of specialized food products for PLHIV with oral problems that can be easily chewed and swallowed to prevent their malnutrition. This study aimed to develop high protein food products in the form of snack with artificial sweeteners, and to determine the levels of acceptance (taste, flavor, color, texture and overall satisfaction) by PLHIV with oral problems. Soybean milk pudding was selected as the food product since it is the most favored snack among PLHIV. All 3 high protein snacks (containing sugar, sucralose, and stevioside) were developed for 30 PLHIV with oral problems, and their sensory perceptions were evaluated. Results revealed there were no significant differences in all aspects of sensory perceptions between the 3 high protein snacks, except for color ($p < 0.05$). In addition, overall satisfaction scores of all 3 high protein snacks were deemed to be acceptable by all PLHIV participants.



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Introduction

Oral problems, one of the major symptoms commonly found in people living with HIV (PLHIV), affected their nutritional status and quality of life. Reports revealed that PLHIV usually suffered from oral problems, such as dry mount, aphthous ulcer, gingivitis, oral candidiasis, and even dysphagia, which were

affected by both anti-retroviral therapy (ART) side effects and opportunistic infections.¹ In addition, oral problems in PLHIV were also used as indicators for predicting severity of the acquired immune deficiency syndrome (AIDS) which can increase risk of mortality among PLHIV.² Oral problems in PLHIV can affected their food habits by reducing abilities in chewing and

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swallowing, leading to losses of appetite and zest for food.³ Moreover, a few studies reported that HIV infection caused increased resting metabolic rate (RMR) that lead to increase in energy requirement. High protein diet is strongly recommended for PLHIV in fighting against opportunistic infections, in supporting immune system, in preventing muscle loss, and in improving the quality of life.^{4,5} Therefore, PLHIV with oral problems are facing more risks of having inadequate energy intake, especially protein, which can lead to malnutrition and muscle wasting compared with PLHIV without oral problems.^{6,7} In order to alleviate these problems providing snacks for PLHIV to increase their energy intakes and to maintain their optimal nutritional status is highly recommended. Experts also suggested that some food modifications with regards to texture and appropriate content of moisture are necessary to enable patients with oral problems to easily chew and swallow their food.^{8,9} Hence, PLHIV with oral problems need special food product with appropriate energy intake, nutritional merit, and food texture to maintain their optimal nutritional status.

Artificial sweeteners (AS) are the sweeten agents that were used instead of sugar by food industries to improve food palatability in variety of food products. In Thailand, sucralose and stevioside are examples of AS that are available in the market and easily found at convenience stores throughout various communities. Previous studies showed that the benefits of using AS to replace sugar include the reduction of sucrose (bad sugar) intake, the prevention of hyperglycemia, the reduced risk from insulin resistance that can lead to type 2 Diabetes development, and the prevention of dental carries.^{10,11} A previous study on the acceptability of a food product using AS was performed using passion fruit juice (*P. edulis*) containing sucralose and stevioside as sweeten agents compared with that using sugar; and it was shown that participants accepted the passion fruit juice with sucralose and stevioside at a level comparable to the formulation containing sugar.¹² PLHIV, need to increase energy intake due to their higher risks of having muscle wasting from the raising of RMR as well as inadequate protein intake. Furthermore, a previous study pointed out that PLHIV are also at risk from ART side effect that can cause hyperglycemia.¹³ In addition, it is well known that high intakes of

carbohydrate and sugar cause dental carries which can lead to less chewing ability and consequently loss of weight.^{14,15} Hence, PLHIV with oral problems need special nutritional product to prevent weight loss and muscle wasting from inadequate protein intake, and to avoid hyperglycemia from the ART side effect. Unfortunately, food products with high protein, low glycemic index that can be easily in chewed and swallowed by PLHIV with oral problems are still unavailable in Thai communities. This study, therefore, aimed to develop the high protein snack using the AS for PLHIV with oral problems and to determine its acceptability.

Materials and Methods

Survey of the most Accepted and Popular Snack

A snack to be used as the test sample that contained high protein with AS was selected by questionnaires that included the list of 20 snack menus as suggested by professionals in dentistry based on the ease in chewing and swallowing, and that they were commonly found in the communities. Examples of the snacks listed in the questionnaires were milky smoothies, milky jelly, and soybean milk pudding. In total, 496 participants were asked to complete the survey questionnaires to choose their most favorite test sample snacks from the list,¹⁶ and the soybean milk pudding was the most chosen snack by the participants.

Development of Sensory Evaluation Questionnaires

This study used sensory evaluation questionnaires adapted from the 9-point hedonic scale (Fig. 1), encompassing the satisfactions of participants on the appearance, taste, flavor, color, texture, and overall satisfaction of the test samples. The test samples with the average score of overall satisfaction above 8 were classified as "acceptable", with the average score of overall satisfaction between 5 and 7 were classified as "passive", and with the average score on overall satisfaction below 5 were classified as "rejected".¹⁷

Development of the High Protein-Soybean Milk Pudding using Artificial Sweeteners

Three recipes of high protein soybean milk pudding (sugar recipe, sucralose recipe, and stevioside recipe) were developed at the Clinical Nutrition Laboratory, Faculty of Allied Health Sciences,



Fig. 1: Nine-point hedonic scale

Burapha University, using the commercial isolated whey protein as the main source of proteins. Energy and amount of proteins of each recipe were calculated using a nutritional analysis software package, INMUCAL-Nutrients V.3 version 3.0, developed by the Institute of Nutrition (INMU), Mahidol University. The ingredients preparation and methods of cooking of all 3 recipes were adapted from the handbook on cookery.¹⁸ The amount of sucralose and stevioside were used according to the previous studies based on the safety doses of both AS.^{19,20}

All questionnaires were submitted to a panel of nutrition and dietetic experts at the INMU and expert professionals in HIV health care at the Queen Savang Vadhana Memorial Hospital for their comments, reviews, and editorial proofreading. Once completed, the edited questionnaires were submitted for ethical approval and revised according to the feedbacks from the Board of Research Ethics of Queen Savang Vadhana Memorial Hospital (approval number 30/2559) before presented to participating 12 PLHIV with comparable and similar demographic characteristics and socio-economic background.²¹

Population

Thirty males and females PLHIV suffering from oral problems at the Queen Savang Vadhana Memorial Hospital were recruited for the study using the purposive sampling technique.²² Only participants who met the following inclusion criteria were recruited: participants with oral problems (ie., wound, teeth loss, dry mouth, dysphagia, etc.) which affected food intake, with age between 18-60 years old, and with willingness to participate in the study. Exclusion criteria includes: loss of sensory function, participants whose did not complete the questionnaires, were unable to participate throughout the study period, had medical history of food allergy.

Study Procedures

Public Relation of the Study

An introductory letter was sent to Director of Queen Savang Vadhana Memorial Hospital providing information on study protocol, and informed consents. PLHIV who came for health care service in Outpatient Department (OPD), Division of Medicine, Queen Savang Vadhana Memorial Hospital, were asked and invited to participate in the study. Each invited PLHIV received an informed consent form and a letter briefly describing the study protocol at the first visit. All participants signed informed consent forms to confirm their agreements to participate in this study.

Data Collection

After signing the informed consent forms, the participants were invited to Clinical Nutrition Laboratory, Faculty of Allied Health Sciences, Burapha University to conduct the sensory evaluations on the developed 3 recipes of high protein-snack (soybean milk pudding) to determine their satisfactions on appearance, taste, flavor, color, texture, and overall satisfaction. The blinded samples of the high protein-snack recipes (sugar recipe, sucralose recipe, and stevioside recipe) were served to each participant. Samples were presented with water and paper ballots on a plastic tray. Participants were asked to intake the whole samples and then rinse their mouths with water between conducting the tastings to minimize any residual effect.

Statistical Analysis

Mean (\pm SD) of age, body mass index (BMI), CD4 level, nadir CD4, viral load level, satisfaction scores were determined. One way ANOVA was used to compare the means of the satisfaction scores between sugar recipe, sucralose recipe, and stevioside recipes. Dependent paired t-test was used to compare the means of the satisfaction scores between sugar and sucralose recipes, sugar and

stevioside recipes, and sucralose and stevioside recipes using the predictive analytics software statistics (PASW) version 21.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was established at $p < 0.05$.

Results

At the baseline, results revealed that most of participants were male with an average age of 40 years. The average body mass index (22.20) indicated that participants were classified as having a normal weight and most had received ART for 1-5 and 5-10 years. Most of participants (80.00%) were in A1 (Asymptomatic with ≥ 500 cells/ μ L), their median of CD4 level was 517.50 cells/ mm^3 , their averages nadir CD4, and viral load were 242.53 cells/ mm^3 , and 495.96 copies/ml, respectively (Table 1).

For the high protein snack recipes, the energy of each recipe per one portion were determined as follows: high protein snack recipe (pudding) with sugar contained 203 kcal, while the sucralose and stevioside recipes contained the same energy per one portion at 143 kcal (Fig 2.)

When focus on macronutrients, results revealed the same amount of protein (14 g) and fat (3 g) per one portion of all recipes. The carbohydrate content of the sugar recipe was 30 g, while that of sucralose and stevioside recipes were the same at 15 g (Fig 3).

For sensory test evaluation, results indicated there were no statistically significant differences on the participants' satisfaction scores in all aspects of 3 recipes, except for the color that revealed the

Table 1: Baseline data on age, body mass index, duration of receiving ART, CD4 level, nadir CD4 level, and viral load

Variables	N (total=30)
Sex	
Male, n (%)	20 (66.66)
Female, n (%)	10 (33.34)
Average age, years (SD)	40.63 (3.63)
Body mass index (SD)	22.20 (2.37)
Duration of receiving ART	
for at least 6 months (%)	7 (23.34)
1– 5 years (%)	10 (33.33)
5 -10 years (%)	10 (33.33)
more than 10 years (%)	3 (10.0)
Oral problems	
dry mouth, n (%)	6 (20.00)
loss of teeth, n (%)	21 (70.00)
dysphagia, n (%)	3 (10.00)
CD4 level*, median (Inter-quartile)	517.50 (35.25)
Nadir CD4 level*, mean (SD)	242.53 (35.34)
CDC category	
A1-Asymptomatic with ≥ 500 cells/ μ L, n (%)	24 (80.00)
A2-Asymptomatic with 200-499 cells/ μ L, n (%)	6 (20.00)
Viral load**, mean (SD)	495.96 (18.42)

*cells/ mm^3

**copies/ml

significant difference of the participants' satisfaction scores (Table 2).

When compared between sugar recipe and sucralose recipe, results revealed there were no significant differences on the participants' satisfaction scores in all aspects of the developed high protein-snack recipes (table 3).

When compared between sugar recipe and stevioside recipe, results revealed there was no significant difference on the participants' satisfaction scores in all aspects of the developed high protein-snack recipes (table 4).

When compared between sucralose recipe and stevioside recipe, results revealed there was no

significant difference on the participants' satisfaction scores in all aspects of the developed high protein-snack recipes (table 5). In addition, the results revealed that the overall satisfaction scores of all 3 recipes were above 8 which indicated that all developed high-protein snack recipes were classified at "acceptable" level by all participants.

Discussion

Nowadays, there have been many attempts to develop innovative food products to improve human wellness. For example, development of functional food products for obese people which use natural dietary fibers as the main ingredient,²³ and the development of snack using the AS which was effectiveness and acceptable by participants.²⁴ In people with oral problems, reports suggested that

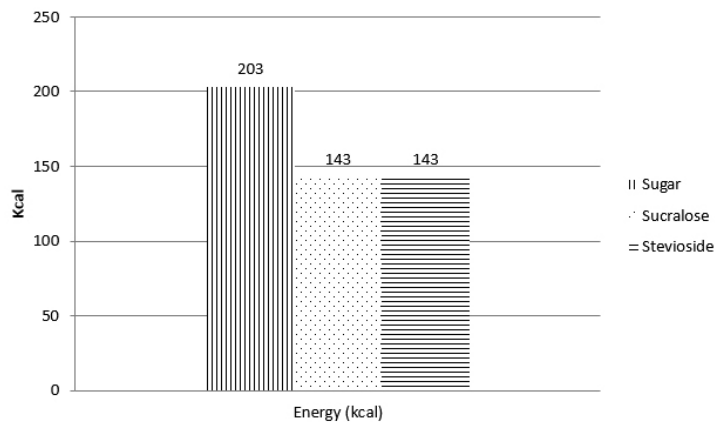


Fig. 2: Energy of the developed high protein snack recipes per one portion

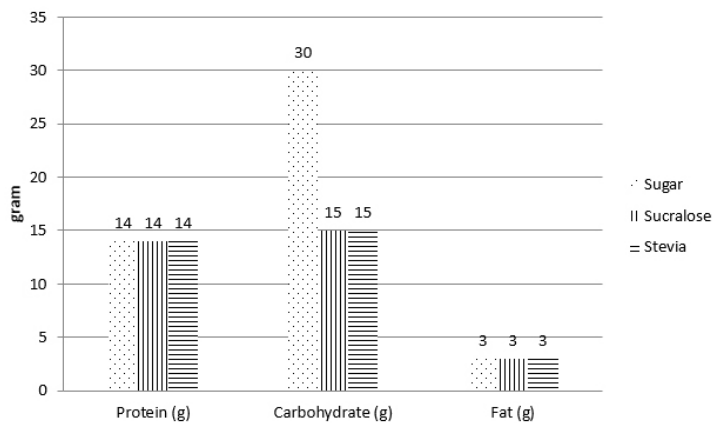


Fig. 3: Amount of macronutrients of the developed high protein snack recipes per one portion

Table 2: Comparison of the participants' satisfaction cores on appearance, taste, flavor, color, texture, and overall satisfaction of the 3 high protein snack recipes

Aspects	Sugar	Sucralose	Stevioside	F	p-value
Appearance, mean (SD)	8.00 (1.04)	8.13 (1.04)	7.93 (1.52)	0.20	0.81
Taste, mean (SD)	7.90 (0.99)	7.80 (1.32)	7.93 (1.08)	0.11	0.89
Flavor, mean (SD)	7.76 (1.07)	7.73 (1.11)	7.93 (1.31)	0.25	0.77
Color, mean (SD)	8.30 (0.87)	7.40 (1.27)	7.30 (0.98)	8.09	<0.00*
Texture, mean (SD)	8.40 (0.77)	8.40 (0.85)	8.30 (1.08)	0.12	0.88
Overall, mean (SD)	8.53 (0.68)	8.36 (0.85)	8.16 (0.94)	1.45	0.24

One-way ANOVA

Total score=9

*Significant difference

Table 3: Comparison of the participants' satisfaction scores between sugar recipe and sucralose recipe

Aspects	Sugar	Sucralose	p-value
Appearance, mean (SD)	8.00 (1.04)	8.13 (1.04)	0.70
Taste, mean (SD)	7.90 (0.99)	7.80 (1.32)	0.62
Flavor, mean (SD)	7.76 (1.07)	7.73 (1.11)	0.79
Color, mean (SD)	8.30 (0.87)	7.40 (1.27)	0.14
Texture, mean (SD)	8.40 (0.77)	8.40 (0.85)	0.69
Overall, mean (SD)	8.53 (0.68)	8.36 (0.85)	0.20

Dependent paired t-test

Total score=9

Table 4: Comparison of the participants' satisfaction scores between sugar recipe and stevioside recipe

Aspects	Sugar	Stevioside	p-value
Appearance, mean (SD)	8.00 (1.01)	7.93 (1.52)	0.46
Taste, mean (SD)	7.90 (0.99)	7.93 (1.08)	0.86
Flavor, mean (SD)	7.76 (1.07)	7.93 (1.31)	0.85
Color, mean (SD)	8.30 (0.87)	7.30 (0.98)	0.54
Texture, mean (SD)	8.40 (0.77)	8.30 (1.08)	0.44
Overall, mean (SD)	8.53 (0.68)	8.16 (0.94)	0.10

Dependent paired t-test

Total score=9

Table 5: Comparison of the participants' satisfaction scores between sucralose recipe and stevioside recipe

Aspects	Sucralose	Stevioside	p-value
Appearance, mean (SD)	8.13 (1.04)	7.93 (1.52)	0.34
Taste, mean (SD)	7.80 (1.32)	7.93 (1.08)	0.56
Flavor, mean (SD)	7.73 (1.11)	7.93 (1.31)	0.70
Color, mean (SD)	7.40 (1.27)	7.30 (0.98)	0.34
Texture, mean (SD)	8.40 (0.85)	8.30 (1.08)	0.63
Overall, mean (SD)	8.36 (0.85)	8.16 (0.94)	0.63

Dependent paired t-test

Total score=9

texture modification is important in improving dietary habits of people suffering from oral health such as dysphagia and dry mouth. The pureed and minced foods are examples of foods whose texture are modified for easy chewing and swallowing for people with oral problems. In addition, the nutritional value and acceptability of foods with modified texture are also considered to be necessary for improving their appetite and nutritional status.²⁵ This study aimed to investigate the satisfaction and acceptability of the developed high protein snack using AS for PLHIV with oral problems who are having high risk in malnutrition caused by inadequate food intake especially dietary protein due to difficulty in chewing and swallowing, to lower the risk of muscle wasting, and to improve immune system to minimize risks of opportunistic infections. The findings of the study revealed that participants expressed satisfaction and acceptability towards the developed snacks using AS comprising both stevioside and sucralose. This findings support previous studies which showed that participants were satisfied with passion fruit juice containing the AS, which indicated that sucralose can be a good substitute for sucrose in passion fruit juice.²⁶ As well, a previous study also revealed that participants were satisfied with the developed muffins using the stevioside instead of sugar.²⁷ However, statistical analyses revealed there was significant difference on the satisfaction scores of color. In contrast, previous study revealed there were no significant difference in all aspects of sensory evaluation scores on the developed yoghurt using

sucralose and stevioside when compared with that using sucrose.²⁸ In the present study, we developed high protein snack using AS using isolated whey protein and soybean milk as protein sources which were reported as to be good sources of high quality proteins for human consumption.^{29,30} However, the limitation of this study was that the data on the effectiveness of clinical intervention on consuming the developed snacks with AS in PLHIV were not collected. Therefore, the long-term investigation of the effectiveness of the developed high protein snacks using AS in lowering the risk of malnutrition among PLHIV should be followed up in further study. This study used AS for preparing the pudding recipes at safety dose levels; however, further study should aim at investigating the possible positive or negative interactions between applications of AS and ART in PLHIV health management. In the present study, results revealed no significant difference on overall satisfaction scores of participants towards the developed high protein snacks using AS compared with the sugar. However, the sample size of this study was limited to a small group of participants; therefore, the results cannot be generalized to the whole population of PLHIV with oral problems. In conclusion, the developed high-protein snacks using the artificial sweeteners are satisfactory and acceptable to PLHIV with oral problems.

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