Sensory evaluation and physical quality attributes of healthy soup: recommended distribution of calories

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Abstract

Carbohydrates (45-65%), protein (10-35%) and fat (20-35%) in the given ranges are recommended for energy intake. To certify the product acceptance, the sensory analysis and some quality attributes of formulated soups were investigated. Based on the results, brown jasmine rice, sweet corn and pumpkin were favored for carbohydrate. Red tilapia fillet and rice bran oil were preferred for protein and fat, respectively. Regarding the energy range recommendation, daily calorie intake (1,600 Cal) and macronutrient sources, 7 formulations of healthy soups (1 ml=1 Cal) were arranged by using INMUCAL nutrients program. The sensory (5 hedonic score, n=12) analysis revealed that all the soup formulas were scored for overall acceptance 3.1-4.9, taste 2.8-4.8, odor 2.8-4.7, texture 3.0-4.7, color 3.0-4.4 and appearance 3.3-4.3, respectively. The most accepted formula contained 14% sweet corn, 16% brown jasmine rice, 41.5% pumpkin, 10.5% red tilapia, 1.9% rice bran oil and 16.1% water, which got the highest score for overall acceptance (4.9), taste (4.8), odor (4.7), texture (4.7) and appearance (4.3) except for color (4.3). the qualities attributes of accepted soup showed the following characteristics of viscosity≈ $1.5x10^4$ cP, pH≈ 6.58 and color value: L*=72, a*=5.5 and b*=57. In addition, *Salmonella* spp./25 ml, *Staphylococcus aureus*/0.1 ml and *Escherichia coli*/0.1 ml were not detected in the developed soup after pasteurization at 100°C for 15 min.

Keywords: *Healthy soup, Energy intake distributions, Sensory evaluation, Physical quality attributes*

Introduction

Unlike the micronutrients; carbohydrate, proteins and fats are main macronutrients that contribute to dietary energy intake. Key of energy is required in the body for metabolic, physiological functions, muscular activity, heat production, growth and synthesis of new tissues. For a given energy intake, increases in the proportion of one macronutrient necessarily involves a decrease in the proportion of one, or more, of the other macronutrients. There is a growing body of evidence that a major imbalance of macronutrient distribution range can increase risk of chronic disease [1,2,3] and may adversely affect micronutrient intake. However, the form of carbohydrate (ex. starches or sugars; high or low glycemic) [1] or fat (ex. saturated, monounsaturated or polyunsaturated fatty acids) [2] is also a major consideration in determining the optimal balance in terms of chronic disease risk.

Based on macronutrient balance, the proportional intake of carbohydrates, protein and fat were recommended to 60:15:25 ratios [1,2,3]. However, higher intake of total carbohydrate and/or fat is an increased risk for obesity and chronic disease [1,2,5], as well as metabolic syndrome and cancer risk [4,6]. High protein intakes probably relate to renal disease, coronary artery disease and cancer too [5,6,7]. Contrary to low intakes of protein have affected the protein-energy malnutrition and impaired immune function and growth. According to Thai Recommended Daily Intakes (Thai RDI) suggested the daily energy requirement about 1600 kcal per day [5] for general people. Thus, the energy per meal was approximately 400 kcal/ main dish (3 meal/day) and 200 kcal/snack dish (2 light meal/day).

To endorse health, not only the energy provider but also the nutritional value of food materials must be taken into consideration. Complex carbohydrates provider energy and dietary fiber including the phytonutrients. Those elements well enhance the digestive tract function, and related the boosting of body immunes. Similar to protein and fat ingredients, the protein's biological values and proportional of saturated: monounsaturated: polyunsaturated fatty acid (1: 1.5: 1) [2] are implication, respectively.

Regarding the criterion of energy distributions and nutritive values were setting to develop the healthy soup by using INMUCAL program to conduct the soup formula depend on food ingredient sources. The participants taste by using sensory analysis which a fundamental tool to assess the product likeness or product acceptance, particularly for new food product developments. Moreover, the physical quality attribute of products such as appearances, colour and texture influence people to make decision whether they want to buy the product or not.

Materials and Methods

The carbohydrates include yellow sweet corn kernel (*Zea mays saccarata variety*), jasmine brown rice (*Oryza sativa L. variety*), and pumpkin (*Cucurbita moschata Duchesne variety*), red tilapia and rice bran oil (King[@]) were formulate for main ingredients providing energy in healthy soups. All food ingredients were purchased from Royal Project Foundation and CP workshop. All materials were analyzed the level of carbohydrate, protein and fat.

All fresh raw materials were cleaned and cut into small pieces before cooking, except for brown rice. Each material was calculateed by INMUCAL software according to the proportional energy ratio between carbohydrates : protein : fat (60:15:25). Those food materials were steamed for 5-10 min, excluding for brown rice was properly cooked by rice cooker and then grinded by electric blender (sharp em-ice, 400 watt) at high speed for 3-5 minutes until observed the homogeneous texture. The amount of water 150 ml was added in 1 part of recipe or serve. To enhance taste and flavor, the pinch of salt was also added. The blended soups was boiled about 15 min then hot filled in cleaned glass bottle and closed the lid, after that followed immediately cool in ice water bath. Ready to eat soup products were kept in refrigerator at 5°C for further analysis.

Sensory analysis (n=12) using 5 hedonic scale was performed to evaluate the preference of soup products. The most accepted soup was followed to examine the pasteurize condition and also measure the quality attribute such as viscosity, texture and pH. Besides, the physical appearance was also evaluated.

Quality analysis

Proximate analysis; Protein was determined by Kjeldahl method. Total fat content was conducted by acid hydrolysis with Soxhlet extraction (HT 1043 Extraction unit, Tecator, Gemini BV Laboratory, Netherlands). Carbohydrate was calculated by subtracting the sum of percentage of protein, fat, ash and moisture from 100%.

Color value was measured by Colorimeter (Hunter Lab model Colorflex 45/0, USA) with pulsed xenon lamp as a light source. The color results were expressed in the CIE L*a*b* (L = brightness, a = red, b = yellow).

Viscosity was determined by Brookfield (DV-II, Brookfield Engineering Laboratories, Inc, USA) at temperature 25°C. Transfer the sample into beaker (500 ml). Mount a spindle in the viscometer, and then lower the spindle into the sample to the depth indicates by mark. Start the motor and let the spindle rotate. Read the viscosity value (centipoise, cP) on the monitor after 30 sec.

The value of pH was measured by pH meter (EcoMet P25 Istex, Inc., Korea)

Microbiological safety was followed by standard BAM methods such as *Salmonella* spp., *Staphylococcus aureus* and *Escherichia coli* at services food analysis of Institute of nutrition, Mahidol University.

Statistical analysis

This study was performed in two independent batches experiment. All analysis was analysed in triplicates. A complete randomized design was studied plan, and used randomized complete block for sensory analysis. All data was analysed by using analysis of variance (ANOVA) and Duncan's significance ($p<0.05$) by IBM SPSS Statistic 19.

Result and discussion

Table 1 Value* of carbohydrate, protein, fat and energy of selected food materials

Food materials** (100g)	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (kcal)
Brown jasmine rice	29.87±1.1	3.11±0.21	1.25±0.10	143
Pumpkin	11.21±1.6	1.3±0.08	0.3±0.03	53
Sweet corn	28.4±2.4	3.3±0.15	1.2±0.05	138
Red tilapia	-	20.4±1.80	2.5±0.11	104
Rice bran oil	-	-	99.78±1.21	989

*The value represented mean ± SD of 3 replications.
** The proximate values expressed in unit g/100 g raw food materials, except for brown rice presented in g/100 g cooked.

Concerning criterion to select the food energy materials were practical access, health benefits and good taste. The preferring food materials for carbohydrates, cooked brown rice (100 g) contained carbohydrate about 30 g, protein 3.1 g, fat 1.3 g, and provided energy 143 kcal. Pumpkin (100 g raw) presented carbohydrate about 11 g, protein 1.3 g, fat 3.3 g and energy 53 kcal. Sweet corn (100 g raw) exhibited carbohydrate about 28 g, protein 3.3 g, fat 1.2 g and energy 138 kcal, respectively (Table 1). Moreover, all selected carbohydrates were

complex carbohydrate and good source of dietary fiber, and also delivered antioxidants, vitamins and minerals; e.g. vitamin B1 in brown rice, beta-carotene and vitamin A in pumpkin and lutein in sweet corn kernel.

Brown rice can reduce risk of colorectal cancer [8]. Pumpkin can reduce hyperglycemia, induced pathogenesis and also associated complication linked to cellular oxidation stress and hypertension [9]. Lutein can reduce risk of age-relate macular degeneration (AMD) and cataract disease [10].

Red tilapia was preferred protein source. It is commonly affordable. It also has abundant of fish meat, no fishy smell, commonly consumed among Thai people, available in the market, low saturated fat, full of essential amino acid complete in elderly and tastes similar to nile tilapia. Red tilapia (100 g raw) presented protein about 20.4 g, fat 2.5 g and energy 104 kcal. Furthermore, fish is source of omega 3 fatty acid that can reduce risk of coronary artery diseased [11], reduce cholesterol and can prevent Alzheimer's diseased. Many studies found that consuming fish at least 1-2 times per week can decrease risk of coronary artery disease and can decrease cholesterol and triglyceride.

World Health Organization (WHO) recommended to consume fatty acid for prevented coronary heart disease (CHD) and possibly other chronic disease at ratio of Saturated Fatty Acid (SFA), Monounsaturated Fatty Acid (MUFA), and Polyunsaturated Fatty Acid (PUFA) at 1, 1.5, and 1 [2,5] respectively. Rice bran oil exhibited ratio of SFA : MUFA : PUFA in consistent that WHO recommended, so this study chose rice bran oil represent to fat group.

Formulation

Pasteurized process is appropriate for food processing in texture, odor, and test similar in real soup and it is not costly. This study formulated 7 soup formulas in different ingredients and nutrient profile according to WHO recommended. The amount of main ingredients were calculated by energy ratio distribution of carbohydrate: protein: fat 60: 15: 25 for kcal and then were converted to quantitative weight. Table 2 shows amount ingredients in the each formula. Each formula had different ingredients.

Table 2 Amount ingredients in each formula

Formula*	Sweet corn (g)	Brown jasmine rice (g)	Pumpkin (g)	Red tilapia (g)	Rice bran oil (g)
A	85	-	-	19	3.7
B	-	95	-	23	3.5
C	-	-	248	20	4.2
D	42	48	-	21	3.6
E	43	-	125	20	3.9
F	-	47	126	22	3.8
G	28	32	83	21	3.8

* Calculated by each formulas.

Nutritive value and energy distribution

Each formula had energy ratio about 200 kcal and nutritive value of macronutrients carbohydrate: protein: fat 60: 15: 25 respectively (table 3).

Table 3 nutritive value and energy distribution

Formula*	Energy (kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	CHO: P: F
A	200.6	30	7.6	5.4	60: 15: 25
B	200	30	7.5	5.5	60: 15: 25
C	200.5	30	7.5	5.4	60: 15: 25
D	200	30	7.5	5.4	60: 15: 25
E	200.5	30	7.6	5.4	60: 15: 25
F	201	30	7.6	5.4	60: 15: 25
G	201	30	7.6	5.5	60: 15: 25

* calculated by each formulas and comfirm on INMUCAL (Institute of Nutrition, Mahidol University)

Sensory quality

Sensory quality was tested in 12 male and female elderly volunteers, aged 60 years old or above. 5 hedonic scale was applied to measure the preference for appearance, color, odor, flavor, texture, and overall acceptability, where 1 means dislike very much, 3 means neither like nor dislike, and 5 means like very much. Sensory quality assessment was explained to the participants to make sure they understood how to rate. Ready to eat soup were served to each subject and served in disposable bowl with a spoon. Participants were asked to sip water between tasting samples and were not allowed to talk to each other.

Table 4 exhibited that overall had score acceptance 3.1-4.9, taste 2.8-4.8, odor 2.8-4.7, texture 3.0-4.7, color 3.0-4.4 and appearance 3.3-4.3, respectively. However elderly subjects preferred healthy soup formula G than any other formulas.

Table 4 Sensory quality tests

Formula*	No. of subject	Sensory acceptability score**					
		Acceptance	Taste	Odor	Texture	Color	Appearance
A	12	3.08	2.75	3.25	3.00	3.50	3.67
B	12	3.08	2.75	2.83	3.08	3.00	3.25
C	12	3.42	3.25	3.58	3.08	3.75	3.92
D	12	3.83	3.75	4.08	3.83	4.17	3.67
E	12	3.92	3.92	3.83	4.00	4.42	4.25
F	12	4.17	4.08	4.08	4.00	4.42	4.17
G	12	4.92	4.83	4.67	4.67	4.25	4.33

* Carbohydrate sources: brown jasmine rice, pumpkin, sweet corn / Protein source: red tilapia / Fat source: rice bran oil
** 5 hedonic scale: 1- dislike very much, 3- neither like nor dislike, 5- like very much

Table 5 Physical quality tests

Formula	Viscosity (cP)	pH	Color*		
			L*	a*	b*
G (BR+pumpkin+corn)	$1.59 \times 10^4 \pm 0.41$	6.58	72.15 ± 0.06	5.52 ± 0.02	56.75 ± 0.11

Formula	Microbiological safety		
	Salmonella spp./25 ml	Staphylococcus aureus/0.1ml	Escheichia coli /0.1ml
G (BR+pumpkin+corn)	ND**	ND	ND

* Color L* = brightness a* = red b* = yellow / The value represented mean ± SD of 3 replications.
** ND = not detected

Viscous of G formula (brown jasmine rice, pumpkin, sweet corn) was 1.596×10^4 cP and had light acid (pH = 6.58) presented it had short shelf life. Color of G formula was the same of the original material yellow color. No bacteria detection found in healthy soup formula G.

Discussion

Healthy soup for elderly with balance energy distribution produced from good quality raw of materials such as source of carbohydrates, protein, and fat and available in the market. All soup formulas had different in carbohydrates, however each formulas was sensory analysis. Most elderly participants preferred the formula with all carbohydrates source (brown jasmine rice, pumpkin, and sweet corn) that smell good and tasty which is a natural taste of the material. The physical quality of developed products such as appearances, color, and texture influence the elderly people to make dicision whether they want to buy this new product in the future.

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