

# Food Exchange List for Sri Lankans with Type 2 Diabetes Mellitus

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## Abstract

The aim of this study was to develop a Food Exchange List for meal planning and assessment of nutrient intake of Sri Lankan type 2 diabetic patients. A cross sectional study was conducted among 55 type 2 diabetic patients and obtained 2 days dietary recalls. From that 50 food items with highest consumption frequency were selected and divided into two groups such as cooked before consumption and consumed as raw. Yielding factors were calculated for cooked foods. One exchange was quantified in household measurements and in respective metric units. The energy and macro nutrient contents in one exchange of all selected foods were calculated by using Indian and ASEAN Food Composition Tables and food labels. Foods were divided into 7 groups. Median values of macro nutrient content in one exchange were considered to be the group representative macro nutrient contents that used to develop the food exchange list. Mean values of macro nutrients intake of dietary recalls derived from developed tool were statistically comparable to reference. Pearson correlation coefficients and Kappa statistics further suggested the validity of the tool against reference. The developed food

exchange list is well suited in planning and quantifying Sri Lankan diets.

**Key words:** Energy, Macro nutrients, Food Composition Tables, Yielding factor

## 1. Introduction

Among the non-communicable diseases world's special attention is devoted to diabetes (World Health Organization, 2015). Diabetes is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Obesity, unhealthy diet, sedentary lifestyle, genetics, age and family history are some risk factors of diabetes (American Diabetes Association, 2003). In Sri Lanka, one in five adults have either diabetes or prediabetes (Katulanda *et al.*, 2008). The prevalence of diabetes for Sri Lankans aged above 19 years was 10.3% and it was higher among urban population (Katulanda *et al.*, 2012). Medical Nutrition therapy is one of the ways to control the disease. The primary goal of Medical Nutrition Therapy (MNT) is to maintain appropriate quantity, quality and time of the meals. In MNT, food exchange list is used as a tool to quantify and plan meals. Sri Lankans have different food habits and

preparation methods based on their ethnicity. Food exchange lists of local foods are almost nonexistent in Sri Lanka. This has resulted in the use of food exchange list developed in western countries to quantify and plan meals. Thus, the development of Sri Lankan Food Exchange List for local foods commonly consumed by diabetes is of imperative.

## 2. Methodology

A baseline survey was conducted as a cross sectional study among 55 type 2 diabetic patients in the age range of 30 to 65 years. Smokers, heavy alcoholics, pregnant and lactating mothers, patients with endocrine disorders and infectious diseases were excluded from the study. Information on food preparation, food purchasing patterns and diet modification after diagnosing diabetes were obtained through an interviewer administered questionnaire along with two days 24hours dietary recalls. A survey was done on the food items available in market which target the diabetic patients. Their nutrition information was obtained from nutrition fact panels.

### 2.1 Nutrients composition analysis

From the baseline survey 50 food items with the highest frequency of consumption were selected and grouped into two; as cooked before consumption and consumed as raw. Yielding factors of cooked food items were calculated as follows; 100 g and 50 g of raw food item were weighed in a cooking utensil separately. Sufficient amount of weighed water was added into them. Then the raw food item was allowed to boil. After boiling, final weight of boiled food item was measured by using an electronic balance. The yielding factor for 100 and 50 grams of food items were calculated separately and

compared with each other. Boiling is a method to find out the yielding factors of rice, legumes, vegetables, green leaves, egg meat and fish. Yielding factors for cooked foods prepared by different cooking practices were calculated to compare the nutrient composition.

The following equations were used to calculate the yielding factors and macro nutrient content in cooked portion.

Equation

$$(1) \text{ Yielding factor} = \frac{\text{Cooked weight (g)}}{\text{Raw weight (g)}}$$

For the calculations on boiled foods,

$$(2) \text{ Nutrient content in 100g cooked food} = \frac{\text{Nutrient content in 100g raw food}}{\text{YF}}$$

$$(3) \text{ Nutrient content in cooked portion} = \frac{\text{Nutrient content in 100g cooked food}}{100\text{g}} \times \text{Weight of cooked portion.}$$

For the recipe or mixed dishes' calculations,

$$(4) \text{ Ingredient 1} = \text{NV}_1 \times \text{RF}_1$$

$$\text{Ingredient 2} = \text{NV}_2 \times \text{RF}_2$$

$$\text{Ingredient 3} = \text{NV}_3 \times \text{RF}_3$$

$$\text{Recipe} = \text{Sum of above} \times 1/\text{YF}$$

(NV= Nutrient Value, YF= Yielding Factor, RF= Retention Factor)

### 2.2 Development of the meal planning tool

Quantity of food for one exchange was defined in household measurements and respective metric units. Energy and macro nutrient content in one exchange were calculated by using Food composition

Tables of Indian, ASEAN and Nutrition fact panel in the labels of food items. All selected foods were divided into 8 groups namely milk & milk products, legumes or pulses, fruits, non-starchy vegetables & green leaves, starch, protein and fat sources. The foods were grouped according to the food exchange list (FEL) by American Diabetic Association (ADA). Within a food group, the median value for each macronutrient of foods were considered to be the group representative value for the particular macronutrient. Decimals of the median values were rounded off to nearest whole number and those values were used to develop the FEL.

### 2.3 Validation of the tool

Twenty-four hour dietary recalls obtained from subjects were quantified for their energy and macro nutrient intake by using

newly developed tool, currently practicing FEL by ADA and foodbase2000 software. The Foodbase2000 software is a nutrient database with Sri Lankan foods and dishes. It was used as the reference indicating actual value for each nutrient content in a food rather than rounded off values from FELs. Mean values for energy and macro nutrient intake from FELs were compared with Foodbase2000 by paired t- test, weighted kappa analysis and Bland-Altman plots.

### 3. Results

Among the subjects, 69% (38) were females and 31% (17) were males. Majority were in the age range of 50 – 59 years including 67% of Sinhalese, 24% of Tamils and 9% of Muslims.

### 3.1 Common foods and preparation methods

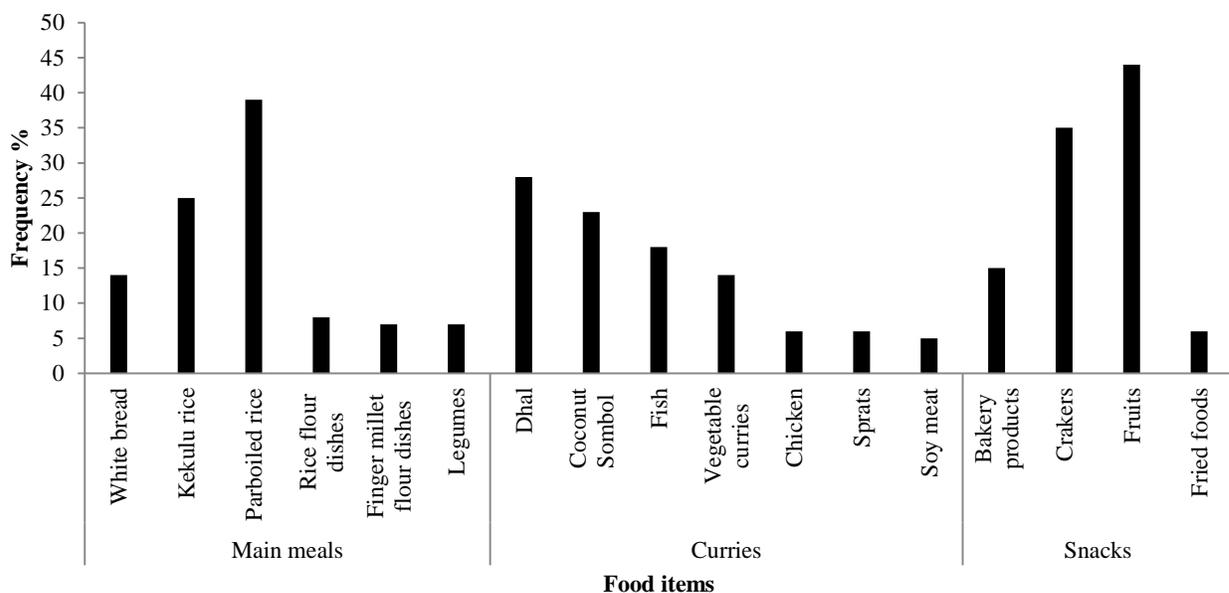


Fig. 1 Consumption frequency of selected foods

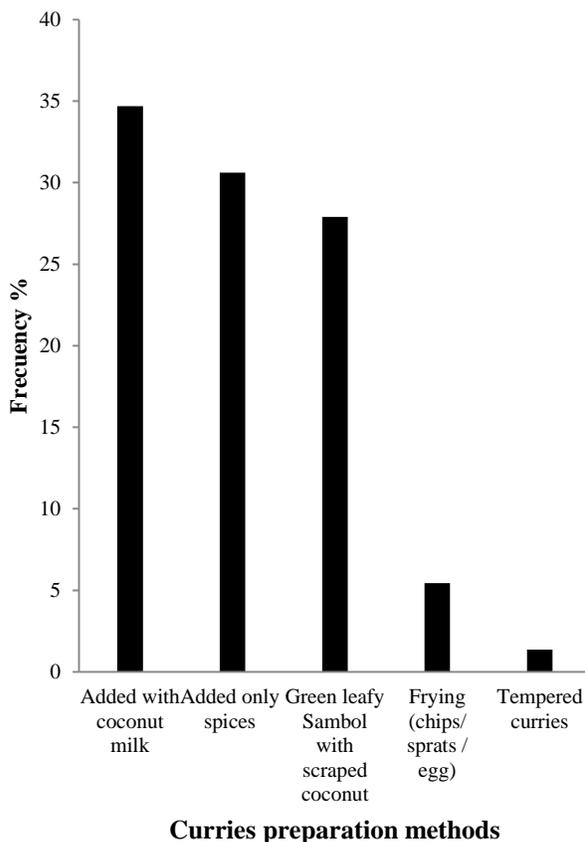


Fig. 2 Preparation method of curries

### 3.2 Diet modifications followed after diagnosing diabetes

Half of the population consumed legumes such as cowpea, chick pea and green grams at least for 3 to 5 days in a week. Nearly 95% consumed non starchy vegetables & green leaves every day. Half of the population consumed fruits on daily basis. One third of the sample has never consumed meat or fish. More than half of the population consumed fish as an animal protein source. Among the meat varieties, chicken had the highest preference while egg was preferred by only 2%. Half of the

population has consumed dairy products other than milk or milk powder at least 2 days per week and 2% of the population has never consumed dairy products.

Majority of the diabetic patients prefer parboiled rice (36%) and wholegrains (35%) for their main meals. Nearly half of the population (45%) consumed tea without milk. Few subjects (7%) used non fat milk powder to prepare tea. Among the fruits, banana (46%) was at the lead followed by papaya (36%). Nearly 80% of the population used coconut oil for cooking. Vegetable oils were consumed by only 13%. Nearly half of the population (55%) consumed 1-3 tea spoons of salt per day. Approximately half of the population (49%) were not consuming added sugar. A considerable percentage of subjects (37%) used  $\geq \frac{1}{4}$  th of the medium size coconut per day for preparing meals.

Most of the subjects followed special diets. Dishes made out of Finger millet (31%), green leafy porridge (22%), Atta flour rotli (18%), Thebukola (*Costus speciosus*) sambol (14%) and bitter gourd dishes such as sambol, juice, curry (8%), black gram dosa or idly (6%) are some of the commonly used special dishes.

### 3.3 Food purchasing behaviors

Majority of the population (89%) consumed homemade foods. Half of the population purchased food items by own self while a family member was responsible for food purchasing for the other half. Only 87% of the subjects had the habit of reading labels. Among them 86% was concerned about expiry date while none of them looked for nutrition facts.

### 3.4 Developed food exchange list

Table 1: Food Exchange List for Sri Lankans with type 2 Diabetes Mellitus

No	Food groups	Exchange	CHO (g)	Protein (g)	Fat (g)	Energy (kcal)
1	Whole milk	1	10	6	8	136
	Low fat milk/ Non-fat milk	1	10	7	0.2-0.4	71
	Skim milk	1	14	9	0.2	94
	Yogurt	1	12	3	3	87
	Curd	1	2	2	2	34
2	Legumes/ Pulses*	1	15	7	0-1	97
3	Non-starchy vegetables**	1	1-4	0-2	0-0.5	29
	Green leaves -uncooked	1	2	0-1	-	12
4	Fruits	1	7-10	-	-	40
5	Starch	1	15-17	3	0-1	89
	Biscuits	1	14-18	2	2-4	116
	Jaggery/ Sugar	1	5	-	-	20
6	Fish/ Meat (lean)	1	-	7	1-3	55
	Egg	1	-	8	8	104
7	Coconut scrapes	1/5 <sup>th</sup> of coconut (40g)	3	1	18-20	196
	Coconut milk – 1 <sup>st</sup> extract	50mL	-	-	20	180
	Oil	1	-	-	5	45

(Legumes/pulses\*- one exchange of chick pea provides 19g of CHO, 7g of protein and 2g of fat.

Non starchy vegetables\*\*:- one exchange of carrot and jack fruit provide 6g of CHO, long beans and leeks provide 7 to 8 g of CHO.)

### 3.5 Statistical analysis for validation of developed tool

Table 2: Means, standard deviation (SD), Pearson correlation and weighted Kappa values of energy and macro nutrients intake for Food Exchange Lists with Foodbase2000 software

Nutrients	Developed FEL				FEL by ADA				Foodbase2000	
	Mean	SD	r	Kappa	Mean	SD	r	Kappa	Mean	SD
Energy (kcal)	1526.1*	227.3	0.986	0.945	1591.1*	249.6	0.858	0.779	1493.6*	239.5
CHO (g)	233.9	49.1	0.997	0.952	245.0*	48.3	0.867	0.772	234.3	50.9
Protein(g)	45.6	10.0	0.988	0.822	47.5	12.3	0.730	0.583 <sup>+</sup>	45.5	10.0
Fat (g)	47.1	8.5	0.941	0.893	46.8	11.3	0.479 <sup>+</sup>	0.410 <sup>+</sup>	46.7	8.5

\*Significantly different at 95% confidence intervals +Moderate association at 95% confidence intervals

Bland Altman plots (Lim, 2012) were used to test the agreement of tools with the

reference. Confidence limits for the energy and macro nutrients derived from developed

FEL were much closer to line of the equality compared with the FEL by ADA in each direction at 95% confidence interval. It indicated a very good agreement of developed FEL against reference. The outliers in Altman plots further suggested the presence of systematic error in quantifications of fat and protein levels using FEL by ADA.

#### 4. Discussion

Sri Lankan's food habits and preparation methods are varied based on ethnicity. Therefore, the study population was selected to have appropriate ethnic representations. The survey identified that majority of the population followed special diets and dietary modifications (avoiding tubers, roots, in cooperate legumes, parboiled rice etc) to control diabetes. Patients have modified food recipes by reducing coconut, salt, sugar and oil or fat. Most of them omitted food preparation methods such as frying and tempering. Thus foods items were prepared according to preparation methods and recipes obtained from subjects.

A modified method was used to quantify macro nutrient contents. This was different to the method by Fadupin (2009). The developed FEL indicates the macronutrient content in one complete exchange of food item rather than burdening the user to use fractions of one exchange to obtain the given amount of macronutrients (Eg: Half a cup which equals to one exchange of 'Kekulu' rice provides 17g of carbohydrates while 15g of carbohydrate is provided by 0.4 cups which equals to 0.8 of one exchange. These fractions are difficult to quantify and make educating patients and planning meals a difficult task). Use of common household

measures facilitates educating patients with no access to measuring scales to quantify food portion sizes.

In the FEL by ADA, legumes are listed under meat and substitutes group as well as in starch group due to their protein and carbohydrate content (Coulibaly, O'Brien, & Galibois, 2009). Since legumes are eaten as main meals in Sri Lanka, they were included as a separate group in developed FEL. It has to be pointed out that legumes group includes pulses such as lentils and beans that are virtually fat free (Harrison & Stalker, 2012).

Since the data distribution was asymmetrical, median value of each macronutrient in all food items within a food group were considered to be the group value for the particular macro nutrient content. Macronutrient content in one exchange of milk and milk products except for fresh milk, was obtained by reading nutrition fact panel in commercially available products. Low values were obtained for fat and protein content compared to the values in FEL by ADA. Green leaves were separated from non-starchy vegetables due to the significant difference in the carbohydrate content. The starch group of the developed FEL provided higher carbohydrate content compared to the value in FEL by ADA. Food preparation methods, cultivar of cereals and geographical location of Sri Lanka may be the main reasons for the observed differences. Biscuits were separated from starch because of the significant difference in the carbohydrate and fat contents. In the fat group; coconut scrapes and coconut milk were separated in the developed FEL owing to the varying carbohydrate and protein content of scrapes. From the baseline survey it was identified

that diabetic patients believe jaggery consumption is healthier than consuming sugar for sweet taste. Therefore, jaggery was added in the developed FEL. Considering Sri Lankan food preparation methods and using Sri Lankan household measurements were the major strengths of the study. The major limitation was the lack of food composition data which led the authors to rely on Indian Food Composition Tables.

## 5. Conclusion

Food Exchange List was developed as a simple, reliable and user friendly meal planning tool for Sri Lankans with type2 diabetes mellitus based on Sri Lankan local foods. The tool can be used by nutrition and dietetic professionals for nutrition education and to quantify and plan meals for diabetic individuals. The developed tool facilitates carbohydrate counting and aids in weight management. This tool can be further modified to use at renal patient set up for protein quantification while adding micro nutrient contents such as Potassium, Sodium and Phosphorous.

## Appendix

Table 3: Exchange sizes of the food items

Food group	One exchange
Milk products	1 Glass of milk (200mL) - 3 tea spoons of milk powder 1 Cup of milk tea (140mL) - 3 tea spoons of milk powder Set yogurt (80mL) 3 Table spoons of curd
Legumes/pulses	½ Cup of cooked pulses (70-75g) 3 Table spoons of Mysore dhal (72g) – Added with coconut milk
Non starchy vegetables	½ Cup of cooked vegetables (48-60g) 3 Table spoons cooked vegetables (48-60g) 1 Glass of vegetable juice (200mL)
Green leaves	3 Table spoons of uncooked green leaves (30g) 3 Table spoons of cooked green leaves- Amaranth (48g)
Fruits	Thin slice of papaya (60-80g) ¼ <sup>th</sup> of guava (60-70g) ¼ <sup>th</sup> of water melon (120g) ½ of orange (70g) ½ of mango (72g) 1 medium size banana (45-50g) ½ of apple (70g)
Starch	½ Cup of cooked rice (62-86g) 3 String hoppers (36g) – medium size ½ Cup of pittu (65g) 1 Atta roti (diameter 10.5cm, thickness 4mm, 42g) 1 Black gram those (diameter 16.5cm, thickness 4mm, 45g) ½ Cup of Finger millet porridge (80g) 1 Bread slice (length 9.5cm, thickness 1.5cm) or 1 ½ slices of cut bread (35-40g)
Protein sources	1 Medium size of boiled Fish/ meat (30g) 1 Boiled egg (50g) 3 Table spoons of cooked sprats (15g)
Fat sources	1 Tea spoon oil (5g) 1/5 <sup>th</sup> of medium size coconut/ scrapes (40g) ½ Cup of coconut milk (50mL) – 1 <sup>st</sup> extract
Biscuits	3 cream crackers/ bran crackers 4 crackers made from finger millet 5 Mari biscuits
Jaggery /sugar	5g of Kithul/ coconut jaggery 7g of Palmyrah jaggery 1 Tea spoon of sugar.

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