VEGETABLE RECIPE VARIATIONS IN URBAN AND PERIURBAN BANGLADESH: RECIPE SURVEY, RECIPE STANDARDIZATION AND NUTRIENT ANALYSIS

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ABSTRACT

Recipe variation has social, economic, geographical, cultural, and other roots. The Analysis of each recipe's composition is not plausible from a chemical as well as an economic point of view. Instead, a standardized recipe from a set of similar recipes could be ideal for cooking and chemical analysis of the nutrient composition of cooked recipes. This type of data has been found to be scanty in conventional food composition tables (FCT) across the globe. Recipe calculation from raw ingredients has always been problematic because cooking is regarded as an unpredictable process on every occasion. Therefore, analysis of cooked recipes is preferred for FCTs which are used for more authentic and accurate in menu planning for individual or community health purposes. The present study seeks to partially fill the information gap on compositional data for vegetable and leafy vegetable recipes consumed by the lower to middle-income urban and peri-urban households of Bangladesh because they have been observed to be the main consumer of these recipes. The study was conducted into three phases. In phase I, a recipe survey was conducted among purposely selected housewives (n=100) representing Dhaka (n=33), Rangpur (n=37), Rajshahi (n=18) and Chattogram (n=12) divisions. In phase II, 10 selected homemade vegetable and leafy vegetable recipes were selected and standardized from the most cited recipe list obtained from consecutive recipe surveys. In phase III, chemical analyses for proximate nutrients were carried out followed by compilation of vitamin and mineral values from local and global food composition databases. The result revealed that the Moisture, Ash, Protein, Fat, Total Dietary Fiber and Available Carbohydrate content (g/100 g) and Calorie of the samples ranged from 71.57-83.68%, 1.30-4.94%, 1.17-5.86%, 0.20-9.18%, 2.63-7.28%, 1.43-14.66%, and 64.94 to 126.28 Kcal respectively. Method validation and analytical quality assurance program was carried out along with all standard operating procedure (SOP) to ensure quality data generation. Therefore, the data obtained in this study can be taken as reliable data which will enrich the food composition database of Bangladesh.

KEYWORDS: Recipe Survey, Recipe Standardization, Nutrient Analysis, Nutrient Data Compilation.

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Introduction

In everyday meals, nutrient-dense foods and recipes are important for good health and well-being. Bangladesh has been blessed a variety of vegetables and leafy vegetables. Vegetables and leafy vegetables are important part of a healthy diet across the world because they are low in calories but rich in dietary fiber as well as vitamins and minerals.

Reliable data on food components have the utmost importance for assessing human consumption behavior in studies related to nutritional and health assessment, epidemiological relationships between diet and diseases as well as nutrition labeling, education and training, national and international trade in foods and a variety of application in trade, agriculture and research development. Effective provision of dietary guidelines, programs and policies as well as laws and regulations are problematic without this dietary information. More up-to-date food compositional data is important for characterizing dietary intakes of individuals or population. Since there is a tremendous increase in the prevalence of diabetes, obesity and other non-communicable diseases, such the dietary information is crucial to investigate the diet-disease relationship(Ferrari P et al., 2008)(Emily F et al., 2017).

Cooking is an unpredictable process causing remarkable variations in the nutrient composition of recipes after cook. Conversely, all FCTs available in Bangladesh list nutrients of mainly raw food items (Shaheen N et al., 2013)(INFS, 1992)(HKI, 1998).These FCTs contained no or negligible recipe composition data. Lack of food compositional data (FCD) on recipes prepared by customary cooking procedure hampers the assessment of diet-health relationships and produces difficulty in the evaluation of dietary consumption of individuals within a population. On the other hand, recipe calculation using regional and international FCTs on cook foods may also produce artifacts because of inter-country variation of FCD depending on botanic and cultivar's origin

along with cooking procedures (Greenfield and Southgate, 2003). Thus, recipe calculation data on nutrient values may be from direct chemical analysis (Gopalan, C. et al., 1971)(Puwastien P, 2000)(UNICEF, Islamabad, Pakistan, 2001). It is, therefore, an utmost importance to get standard recipes of foods commonly consumed by a population that are usually prepared by cooking procedures customary to local tradition(Greenfield and Southgate, 2003) . Foods and recipes "as consumed" by Bangladeshi population have local variations with locally available ingredients. Recipe surveys to identify key mainstream and ethnic cook foods is, therefore, also essential and desirable.

Concentrations of nutrients in cooked foods and dishes have been analyzed in our laboratory for more than 20 years. As a continuation of these studies, a recipe survey has been conducted among selected urban and peri-urban households located in Gaibandha, Bogura and Chattogram districts of Bangladesh and Dhaka city to collected recipes on vegetable dishes followed by standardization of selected recipes. Laboratory analysis for the proximate composition of the standardized recipes was carried out followed by compilation of missing nutrients from local and global FCDBs. All analytical SOPs were AOAC (Association of Analytical Chemist) methods.

Materials and Methods

Recipe collection survey

A survey was conducted among 100 purposively selected housewives of low to middle-income households residing in Gaibandha, Bogura, Chattogram districts and Dhaka city to collect a list of multi-ingredient recipes which they usually prepare for family consumption. The survey was conducted using a pretested survey questionnaire by interviewing the participants face-to-faces on the basis of their oral consents. The mothers were asked to describe at least ten recipes they used to prepare along with ingredients and amounts used for these recipes using a pre-tested questionnaire, which was established in our laboratory several times. Also collected was the information on seasonality, availability, and preparation frequency of the foods they consumed in order to develop a key food list. Other relevant information regarding recipe preparation was also collected. A similar recipe from the cookbook (Siddika Kabir,1983) was also extracted to obtain a comparison with the recipe preparation procedure obtained through the survey.

Selection and standardization of recipes

Standardization of recipes was conducted as per the protocol established and validated in our laboratory over time (Ara, 2004) (Jahan, 2005) (Mustary, 2009) (Mahbuba, 2018) (Tithi, 2020). Briefly, the name, amount, size, and volume in each ingredient of each recipe were listed on the basis of the proportion of the total citation percentage. Those recipes were considered to be listed which have a cutoff citation percentage ≥ 1. Next, the mode of an ingredient and its corresponding amount in gram or serving size were coined for making a standardized recipe for the representation of all the recipes listed. The cutoff point of citation percentage was determined for each recipe on the basis of the minimum and within the economic reach of the participant household with minimum ingredients necessary for making a recipe.

Preparation for laboratory analysis of selected standardized vegetable curries

The ingredients of the selected standardized recipes were purchased from local markets and used immediately for food preparation. If the selected recipes involved cooking, then the ingredients were adjusted for cooking effects like boiling, baking, frying, etc. Recipe weight before and after cooking were recorded to calculate cooking yield factors according to Bognar and Piekarski (2000). Samples were blended immediately after preparation and a portion of the cooled samples was immediately analysed for moisture contents (NIN 2003). Rest of the samples were oven dried at $65^0 \pm 5^0$C for 12-14 hours, powdered and stored in desiccators until use.

Table 1. Ingredients and their amounts for ten selected vegetable and leafy vegetable recipes

Recipes	Ingredients (g) and Preparation procedure (PP)	Total raw weight (g)	Total cooked weight (g)
Water spinach fry	Water Spinach Leaves(425), Soybean Oil (22.5), Salt (7.5), Green chili (17.5), Onion (30), Garlic (11) PP: After cleaning and washing, the water spinach leaves were boiled in small amount of water with green chili and salt at medium flame for 8-10 minutes. Then oil was poured into a pan and garlic gloves were added and heated for 2 minutes. After that, the boiled leaves were added in the pan and stirred continuously till the water spinach leaves were dried completely.	514	403
Red amaranth fry	Red amaranth Leaves(425), Soybean Oil (22.5), Salt (7.5), Green chili (17.5), Onion (30), Garlic (10) **PP:** After cleaning and washing, the red amaranth leaves were boiled in small amount of water with green chili and salt at medium flame for 8-10 minutes. Then oil was poured into a pan and garlic gloves were added and heated for 2 minutes. After that, the boiled leaves were added in the pan and stirred	517	273

	continuously till the red amaranth leaves were dried completely.		
Bitter gourd fry with tomato	Bitter Gourd (100), Potato (113), Salt(3), Soybean oil(7), Onion(19), Green chili(6), Turmeric(1) **PP**: Oil was poured into the pan and sliced potato, bitter gourd, green chili, onion, salt, and turmeric powder were added and mixed all well together. A small amount of water was then added and covered with lid for 12-15 minutes. After evaporating water, oil was added and stirred continuously till the dish was dry.	299	208
Pumpkin fry	Pumpkin(339) , Soybean oil(9), Salt(5), Onion(15), Green chili(10), Turmeric(2) **PP**: Oil was poured into the pan and sliced pumpkin, green chili, onion, salt, and turmeric powder were added and mixed all well together. A small amount of water was then added and covered with lid for 12-15 minutes. After evaporating water, oil was added and stirred continuously till the dish was dry.	430	331
Pointed gourd fry	Pointed Gourd (154), Salt (2), Soybean oil (11), Red chili powder (3) **PP**: Each Pointed gourd was sliced twice and then mixed with salt, turmeric powder, and red chili powder. Next oil was poured in a pan and pointed gourd slices were fried for 7-10 minutes.	173	129
Bitter Gourd fry	Bitter gourd (320), Onion (30), Salt (2.5), Soybean oil (20), Green chili (5), Turmeric (2.5) **PP:** Firstly, bitter gourd, onion and green chilies were washes and sliced them. The all ingredients were taken in the fry pan and mixed them properly and treated with mild heat. After some time, it was fried and the picked up from the oven.	380	235
Lady's Finger fry	Lady's finger(300), Tomato(95), Onion(3), Salt(3), Soybean oil(20), Ripe chili(3.5), Garlic(3), Turmeric(1) **PP:** Lady's finger, tomato and onion were washed. Oil was taken in the fry pan and all ingredients except Lady's finger were mixed with this oil properly. Then sliced lady's finger were given in the mixture and fried. After that tomato was added and the pan was covered. The process was completed with mild heat.	428.5	230
Lentil with mixed vegetables	Lentil(100), Cow pea(60), Pui leaf(100), Pui stem(50), Green papaya(75), Green chili(10), Soybean oil(30), Salt(2), Cumin paste(0.5), Ginger paste(2), Water(500) **PP:** Lentil was boiled in water along with green chilies, salt, and turmeric powder. Then it was beaten up with a pestle to mix the lentil with water. Then the cow pea, *pui* and papaya were added and cooked till vegetables become boiled. Mustard seeds were fried in oil, ginger and cumin powder also fried and then boiled lentil was put in it.	929.5	778
Green gram with Bottle gourd	Green gram (100), Bottle gourd(220), Green chili(10), Soybean oil(15), Salt(2), Coriander leaf(2), Ginger paste(2), Mustard seed(0.1), Turmeric powder(0.5), Water(500) **PP:** Green gram was boiled in water along with green chilies, salt, and turmeric powder. Then it was beaten up with a pestle to mix the lentil with water. Then the bottle gourd was added and cooked till bottle gourd becomes boiled. Mustard seeds were fried in oil and boiled green gram was put in it.	851.6	695
Potato mash	Potato (400), Onion (14.5), Mustard oil (2), Green chili (4), Salt (2.5)	423	344

	PP: At first, the tomato with its cover was boiled in hot water. After that the cover was removed. The potatoes were mashed to make a semi-paste. Then green chili, onion slices, salt and sufficient amount of oil were added and mixed with the paste properly.		

Proximate analysis

Homogenous samples dried samples in sachets were taken out from desiccators for proximate analysis. Official Methods of Analysis (OMA) of AOAC (2000) was used in most cases. Moisture free samples were analysed for ash, protein (OMA 984.13), and fat (OMA 922.06 & 991.36 on sample basis). For determination of total dietary fiber (TDF), adoption of the Prosky method (OMA 985.29) was used because it supports the Trowell's definition of TDF (McCleary, 2023). All samples were analyzed in duplicate with triplicate or quadripartite estimations for each parameter. The nitrogen free extracts (NFE) were considered as total carbohydrate and were calculated by the following equation: carbohydrate (g/100g) = 100 - (moisture + protein + lipid + dietary fiber + ash) g/100 g. Energy content of each HMRI was calculated by using Atwater Factors (Atwater 1910): the metabolizable energy (MEn) for carbohydrate (c), MEc = 4 kcal/g; for fat (f), MEf = 9 kcal/g; and for protein (p), MEp = 4 kcal/g.

Quality Assurance Program (QAP)

For each analytical methods, coefficient of variation (CV) was determined in a quantitative manner as an index of precision; a CV <10% was taken as acceptable. On the other hand, instead of commercial reference materials, an in-house-reference material (IHRM) was used to check the accuracy of nutrient values of the foods analyzed by co-analysis of a portion of IHRM in each batch of analysis.

Data compilation for vitamin and mineral values

Unanalyzed nutrient values i.e., contents of vitamins and minerals were compiled from various local (FCTB 2013), regional (IFCT 2017), and global datasets by using the FAO/INFOODS Data Compilation Tool version 1.2.1. (FAO/INFOODS cited 2023). Final value of each calculated nutrient value was adjusted for water and fat corrections.

Results

Socio-demographic features of the respondents

The socio-demographic profile of respondent housewives participated in the recipe survey are presented in Table 2.

Total number of respondents was 100 after data cleaning. Majority of the participants were housewives (62%) and aged above 30 years (80%).

Table 2. Socio-demographic features of the respondents, n=100

Characteristics	Frequency (%)
Age (Years)	
< 30	20
30-40	44
> 40	36
Education	
≤ Graduate	27
HSC-SSC	56
< SSC	17
Occupation	
Housewife	62
Working	16
Student	22
Family Income	
< 10,000	14
10,000-30,000	56
> 30,000	30

Survey results and recipe profiles

A total of 18 vegetable and leafy vegetable recipes were cited by the respondents which they prepare at home for consumption of family members. Table 3 showed the recipes which were cited at least 3 or more times by the participants of the study. Some of these foodstuffs are prepared occasionally or seasonally, and some of them frequently. The total number of citations of all the cited food items was 500.

Table 3. Recipes cited by respondents

Food items	No of citation	% of total citation
1. Red Amaranth leaves fry	68	18.4
2. Water spinach leaves fry	45	9
3. Pumpkin fry	41	8.2
4. Potato mash	37	7.4
5. Bitter gourd with potato	34	6.8
6. Pointed gourd fry	33	6.6
7. Lady's finger fry	32	6.4
8. Bitter gourd fry	31	6.2
9. Green gram with Bottle gourd	26	5.2
10. Lentil with Mixed vegetables	23	4.6
11. Lentil with potato	23	4.6
12. Brinjal fry	21	4.2
13. Bitter gourd fry	19	3.8
14. Radish leaves fry	11	2.2
15. Jute leaves fry	10	2
16. Bottle gourd leaves fry	8	1.6
17. Jack fruit's seed mash	6	1.2

Total citation of all 18 items = 500

Ten recipes were selected on the basis of high citation and availability of ingredients and standardized (Table 3) for analysis.

Proximate Composition and Cooking yield (%) for the standardized recipes

Since the analyses were performed on dry weight basis, final results were prepared by adding water content into per 100 g of each sample and treated as fresh. Cooking yield data were calculated by the definition of Bognar (Bognar, 1998) and presented in Table 4 with proximate composition and energy values of the sample recipes.

Table 4. Energy and Proximate nutrient value of the sample recipes (g/100g ED) with cooking yield (%)

Food Items	**Moisture**	**Ash**	**Protein**	**Fat**	**Available CHO**	**TDF**	**Energy (kcal)**	**Cooking Yield (%)**
Bitter gourd fry	77.12 ± 0.41	1.63 ± 0.08	1.32 ± 0.06	1.02 ± 0.03	12.52	6.39 ± 0.07	77.32	61.84
Bitter gourd-potato fry	80.79 ± 0.51	2.84 ± 0.12	2.15 ± 0.17	3.05 ± 0.07	7.59	3.58 ± 0.09	73.57	69.57
Green gram-bottle gourd	81.64 ± 0.2	1.54 ± 0.01	3.51 ± 0.38	3.35 ± 0.13	5.64	4.32 ± 0.54	92.67	83.68
Lady's finger fry	72.02 ± 0.29	1.99 ± 0.10	1.8 ± 0.22	2.25 ± 0.07	14.66	7.28 ± 0.19	100.65	53.72
Lentil with mixed veg	83.68 ± 0.1	1.92 ± 0.03	3.85 ± 0.53	2.88 ± 0.4	2.28	5.39 ± 0.62	82.78	81.64
Pointed gourd fry	79.15 ± 0.45	2.03 ± 0.06	2.16 ± 0.16	5.35 ± 0.15	6.98	4.35 ± 0.16	93.33	74.57
Potato mash	81.40 ± 0.11	1.3 ± 0.14	1.8 ± 0.18	0.2 ± 0.01	12.67	2.63 ± 0.12	64.94	81.40
Pumpkin fry	82.31 ± 0.03	1.73 ± 0.02	1.17± 0.07	4.18 ± 0.06	6.98	3.57 ± 0.24	77.9	76.98
Red amaranth fry	71.57 ± 0.38	4.94 ± 0.14	5.86 ± 0.32	9.18 ± 0.02	1.66	6.79 ± 0.59	126.28	52.80
Water spinach fry	77.48 ± 0.74	2.98 ± 0.12	4.63 ± 0.16	6.48 ± 0.02	1.43	7.01 ± 0.79	96.57	78.40

* ED, Edible portion
* Results are expressed as mean of triplicate estimations SD
*Carbohydrate and energy are calculated from the mean of each sample

Determination of mineral and vitamins using FAO data compilation tool

Unanalyzed nutrient values, vitamins and minerals were compiled from various local, regional, and global datasets using the FAO/INFOODS Data Compilation Tool version 1.2.1. Quality checks were applied throughout the compilation process by applying FAO/INFOODS Guidelines. Since each compiled value was adjusted for water and fat in order to harmonize with the proximate values, variations from real values have been expected to be insignificant.

Table 5. Vitamin content of the sample recipes

Food name	Thia Min (mg)	Ribo flavin (mg)	Niacin equi - valents (mg)	Vit B6 (mg)	Folate (mcg)	Vit C (mg)	Vit A (mcg)	Beta - Carotene equivalents (mcg)	Vit D (mcg	VitE (mg)
Bitter gourd fry	0.07	0.06	0.60	0.04	45	103	152.5	305		0.04
Bitter gourd-potato fry	0.07	0.05	0.80		19	81	365.5	731		
Green gram - bottle gourd	0.12	0.04	1.40		10	11	476	952	839.3	
Lady's finger fry	0.17	0.03	1.50		30	9	147	294		
Lentil with mixed veg	0.05	0.04	0.90		11	0	94	116		0.07
Pointed gourd fry	0.30	0.03	0			44.2	35	70	171.3	
Potato mash	0.07	0.10	0.40	0.25	14	16.5	16	32		0.03
Pumpkin fry	0.14		0.20		10	7	477.3	955		14.8
Red amaranth fry	0.01	0.27	0.62	0.22	81.95	86.3	4729	9457		6.41
Water spinach fry	0.07	0.09	1.9		62	15	4552	8968	0.095	1.91

Table 6. Mineral content of the sample recipes

Food Name	Fe(mg)	Ca(mg)	Mg(mg)	P(mg)	Na(mg)	K(mg)	Cu(mg)	Zn(mg)
Bitter gourd fry	2.90	27	48	34	469	304	0.44	0..61
Bitter gourd-potato fry	2.20	29	33	51		340	0.26	0.50
Green gram - bottle gourd	2.29	23	25	85	13	261	0.15	0.80
Lady's finger fry	0.96	108	43	58	166	315	0.11	0.50
Lentil with mixed veg	0.89	8	21	62	201	204	0.09	0.40
Pointed gourd fry		17.32	15	17.61	28.17	147.9		
Potato mash	0.60	14	23	44	310	273	0.47	0.85
Pumpkin fry	0.10	23	7	15	76	84	0.02	0.20
Red amaranth fry	7.25	245	117	76	14.58	564	0.22	1.37
Water spinach fry	2.59	188	62	57	843	571	0.05	0.80

Discussion

Food preparation at home always been an unpredictable process. Loss of water, decomposition of protein, fat evaporation, loss of mineral and water-soluble vitamin through leaching, soaking, and extraction are common during food processing and preparation. The availability of some nutrients might also change in either a positive or a negative way. Therefore, recipe calculation from databases is always different from chemical analysis. And analytical values represent more close to accurate content of nutrients.

To fill the information gap on food composition data for cooked foods and dishes consumed by the Bangladeshi people, a number of foods and dishes have being analyzed for their proximate compositions in our laboratory since 2003 and onwards. As a continuum of the previous works with previous cook food analysis, the present study was undertaken to analyze ten selected cooked vegetables and leafy vegetables identified as being among the most commonly consumed which resulted from a survey conducted among 100 households after data cleaning, residing at different areas of Gaibandha, Bogura , Chattogram districts and Dhaka city.

The findings of the study revealed that the demographic characteristics of the respondents are less homogenous, 62% of respondents are housewives. Almost half (44%) of respondents were in their age range between 30 and 40, 14% of respondents belonged to low-income families (<10,000 TK/Month) and only 17% of respondents were found below

the S.S.C. level in terms of education. A total of 18 type vegetable and leafy vegetable recipes were identified from the recipe survey and from them the highest ten cited foods were selected for standardization and analysis presented in Table 2.
This study estimated the contents of moisture, ash, protein, fat, carbohydrate, TDF, and calorie value of ten selected recipes (Table 4) Red Amaranth leaves, Water Spinach, Bitter gourd with Potato, Pumpkin fry, Pointed gourd fry, Bitter gourd fry, Lady's finger fry, Green gram with bottle gourd, Lentil with mixed vegetables and potato mash. The moisture content ranged from 71.48-83.68% (g/100g of fresh sample), which is considerably high due to leafy vegetable and vegetables recipes. The carbohydrate contents of leafy vegetables were naturally in lower level (1.43-1.66%) in comparison with vegetables (6.96-14.66%). The ash content of the food ranges from 1.3 to 4.94% depending on the added value of salts in recipe preparation. The fat content was considerably high (6.48-9.18%) especially for leafy vegetable recipes due to the addition of a large amount of oil during cooking. The TDF content ranges from 2.63-7.28%, showing relatively higher values for leafy vegetable recipes as they are good sources of fiber. The energy content of 100 g of recipes ranges from 64.94 kcal to 126.28 kcal as they contain a high amount of fat due to the addition of oil during preparation. The cooking yield factors shown in Table 4 for the ten selected recipes indicated that these factors depend on the type of ingredients of the recipes as well as on the type of cooking procedure.

Some selected vitamin and mineral content of public health importance were estimated by data compilation procedure (Table 5 and 6) as elaborated in the methodology. Data compilation option was adopted to minimize the data production cost as well as due to limitations of sophisticated analytical instruments. A few values remained missing due to the unavailability of secondary food compositional data.

Since, precision and accuracy of analytical values were checked by a QAP as described in the methods and materials section the data produced in this study can be considered quality food composition data for cooked foods and dishes. Hence these data can be considered worthy for any secondary uses in food, nutrition, and health policy and programs.

Conclusion

The present study was undertaken to collect, process and analyze ten selected vegetable and leafy vegetable recipes as are commonly consumed in urban and semi-urban areas of Bangladesh. The study constituted a nutrient composition table of ten selected recipes thereby supplementing the food composition database of Bangladesh. Therefore, this study provided recipe compositional data for cooked food consumed by Bangladeshi people to fill information gap in these areas. The quality of the data generated from this study can be considered to be high as they are precise and valid. Therefore, the data generated from this study can be used as reliable data which will enrich the national food composition table.

Limitations of the study

There are also some limitations to this study. 1) After data cleaning, total respondents were reduced from 110 households. If sample size was higher, the total citation percentage would be higher and standardization would be better. 2) Due to insufficient and advanced instruments and reagents, vitamins and minerals were not being directly estimated, rather obtained by compilation. 3) In determining nitrogen free extract, the nitrogen factor 6.25 was used due to a lack of actual nitrogen factor for vegetables and leafy vegetables. That might produce different findings from the actual values.

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