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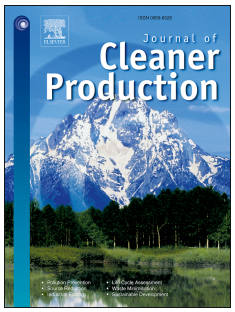

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Assessment of nutritional loss with food waste and factors governing this waste at household level

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Abstract

One third of food produced for human consumption is lost or wasted meanwhile one billion people on the earth are suffering from hunger and malnutrition, making food waste a major sustainability issue. Food appropriate for human consumption but ultimately ends up unconsumed or discarded is called food waste. Reducing food waste can bring down the food

costs, benefit the environment, and improve food security and human health as food comprised of various nutrients which are vital for disease prevention. Food and nutrition waste estimation is essential to provide awareness among the general public regarding importance of food which is thrown away as waste and to develop policies on regional and global level to reduce food waste or redirect surplus food to needy people before it going to waste. The current study aimed to (i) determine the level of food waste and its composition by types (ii) calculate the nutritional losses from food wastes and (iii) examine the causes of food waste at household level in tehsil Kahror Pakka, Pakistan. To explore these objectives, food waste generated during 24 hours was collected from fifty one households, sorted and weighed into different types such as fruit, vegetables, cooked food, processed food, meat including fish and poultry and dairy products. Maximum food waste was associated with cooked food (35.02 g) whereas, minimum waste was reported by dairy products (1.98 g) per capita per day. Nutritional value of food waste was estimated by comparing the values of each food item with food composition table for Pakistan. Total amount of household food waste represented an estimated value of energy (54.42 kcal), protein (2.61 g), lipids (2.21 g), carbohydrates (10.58 g), fiber (0.75 g) β-carotene (275.2 mcg), and vitamin A (96.83RE), calcium (Ca) (22.49 mg) and phosphorous (P) (37.11 mg) per capita per day. Energy losses were higher from cereals (79%) while moisture losses were higher from fruits (53%) and vegetables (69%). Approximately 2.6% of total kcal requirement (2100 kcal) of Pakistan food basket was wasted with food waste. In a survey, most respondents reported that cooked food is wasted as it looks bad (50%), misplanning of meal (40%) and cooked improperly (36%). Processed food is mostly wasted due to unawareness of respondents regarding labeling dates (50%).

Highlights

- Attempt to estimate the nutritional value of food waste and its causes in study area.
- Cooked food waste was higher while dairy waste was lower at household level.
- Energy and Phosphorous losses were higher from cereals waste.
- About 21.4% of daily fruit and vegetable requirement was wasted with food waste.

Key words: Behavior; Consumer attitude; Labeling dates; Nutritional value; Waste management;

Abbreviations

Ca: Calcium; Carb: Carbohydrates; Chol: Cholesterol; P: Phosphorous; Fe: Iron; Zn: Zinc; I: Iodine; Th: Thiamin; Rib: Riboflavin; Vit: Vitamin; WRAP: Waste Resource Action Plan; UK: United Kingdom; USA: United States of America;

1. Introduction

Food comprised of many macro (proteins, carbohydrates, fiber) and micro nutrients (vitamin and minerals) which are essential for growth, development and well-being of human. Every year one third of food produced for human consumption is wasted from farm to plate (Gustavsson et al., 2011). Food waste results in wastage of resources used for its production like water, crop land and soil fertility. As these resources are limited in nature, they should be used sustainably and efficiently (Beretta et al., 2013). Wasted food causes air pollution (pesticide and fuel burning for food production and distribution) and water pollution (eutrophication due to indiscriminate fertilizer application), affecting ecosystems and biodiversity and increasing greenhouse gas emission due to its rotting in landfills. Food waste also results in huge economic losses (Segre et al., 2014). Reducing food waste can improve the efficiency of food value chain by reducing the

cost of food and hence increasing the purchasing power of marginal households (Gustavsson et al., 2011).

In developing countries, food losses and waste are higher during harvest and transportation whereas in developed countries these losses are higher at consumer level (Lipinski et al., 2013). However, despite huge food losses and waste, one billion people living on the planet are suffering from hunger and malnutrition (FAO, 2009). Food waste also results in wastage of all the nutrition present in the foods. According to an estimate, roughly 1,500 food calories per capita per day are lost or wasted in US food supply chain (Reich and Foley, 2014; Buzby et al., 2014). In North America and Oceania, maximum calories loss (1,520 kcal per capita per day) with food waste occurred whereas, minimum calorie loss (414 kcal per capita per day) was found in South and Southeast Asia (Lipinski et al., 2013). On an average, one out of four calories intended for consumption is not consumed by the people (Lipinski et al., 2013). In United States food supply chain during 2012 food wasted at the retail and consumer levels contained energy (1,217 kcal), protein (33 g), dietary fiber (5.9 g), vitamin D (1.7 μg), calcium (286 mg), and potassium (880 mg) per capita per day (Spiker et al., 2017). Vitamin A losses in Norway and Kenya and vitamin A and C losses in seven world regions (Europe, North America and Oceania, Industrialized Asia, Sub-Saharan Africa, North Africa, West and Central Asia, South and Southeast Asia and Latin America) were investigated in fruit and vegetable supply chain (Serafini et al., 2015; Lee et al., 2015) to highlight the connections between food waste and nutritional insecurity.

Food waste is seen as an obstacle to achieving food and nutrition security for the millions of undernourished around the world (Bagherzadeh et al., 2014). Almost 870 million people - or one out of eight people in the world - were undernourished with vast majority of people (852 million

or 14.9% of the total population) live in developing countries in 2010-2012 (FAO, 2013). Over two billion people in the world are micronutrient deficient (Serafini et al., 2015). Stunting rates exceeded 40% in South and Southeast Asia between 2005 and 2011 (FAO, 2013). This situation is also aggravated in developing countries of the world including Pakistan. According to National Nutritional Survey, in Pakistan 47.3% children under the age of five were stunted, 15.1% were wasted and 31.5% were underweight (Anonymous, 2011a). Moreover, natural calamities like drought also caused food insecurity in the country which resulted in 500 deaths due to poor cereal production and resulted in huge inflation in food prices in 2014 (Global Emergency Overview Update, 2014). Reducing food and nutrient losses can feed hungry people and improve their health by providing essential nutrients in their diet. Limited information is available on nutrient losses with food waste at household level in developed and developing countries to the best of our knowledge.

In UK, it was found in a research project that the reduction in food loss in the entire food value chain will be a critical component of any sustainability plan and equitably feeding the fast growing global population (Foresight, 2011). Food waste studies done at various stages of food supply chain (production, distribution, retail and consumer level) in the world revealed that food waste at household level is a significant fraction of total food waste (Beretta et al., 2013; Oelofse and Naham, 2012). To increase the efficiency and reduction in environmental impact of food consumption, it is highly practical to reduce the food losses in an effective way.

Several studies were done in many developed countries to find the reasons behind the food waste, so that the issue of food insecurity would be tackled. The main reasons find in these studies were; poor quality food, improper storage, food not used with in time, improper meal planning, plate waste, aversion of eating leftovers, lack of awareness of impact of food waste is

some of the major reasons for food waste at household level (Reich and Foley, 2014). However, reasons for household food losses in developing countries with special reference to Pakistan are lacking. So exploring the reasons of food waste at household level is important to understand food wasting behaviors and to identify the options in designing food waste reduction measures.

Overall, to reduce food waste, its quantification and estimation and also knowing the reason governing these losses is necessary. Estimating food and nutrition waste can provide the awareness among the general public regarding importance of food which is being thrown away due to consumers behavior. Policies can be developed on regional and global level to reduce food waste or redirect surplus food to needy people before it got waste.

So the current study is designed with the objectives to estimate the nutritional losses associated with food waste and factors governing this waste at household level in tehsil Kahror Pakka Pakistan.

2 Materials and Methods

This is an exploratory study with the main purpose of estimating nutritional losses governed by food waste at household level and the reasons for food waste. The study includes questionnaire survey, food waste collection from the households, food waste segregation and estimation (quantitative and nutritional).

2.1 The study area

The study was carried out in Kahror Pakka tehsil (an administrative sub division of district) of District (district is the third order administrative division below province and division) Lodhran, Punjab, Pakistan (Figure 1). Kahror Pakka is located on the northern side of River Sutlej. Dunyapur tehsil is located on its north side, Bahawalpur District on its west and District Vehari

lies towards its east. Its geographical coordinates are 29° 37’ 0” North, 71° 55’ 0” East. According to the Punjab developmental statistics, the 2011 population of Kahror Pakka was 464,000 (Anonymous, 2011b). The climate is very hot and dry in summer and cool in winter. In summer maximum and minimum temperature ranges between 42°C and 28°C and in winter between 21°C to 5°C respectively (Anonymous, 2012).

2.2 Food waste estimation

Fifty one households were selected from the study area by using random sampling. Food waste sampling from selected households was done from mid December 2015 to mid March 2016. For this purpose, plastic bags were given to the households to keep their one day (24 hour) food waste. They were provided with six plastic bags for keeping cooked food, dairy products, processed food, cereals and fruits and vegetables separately. Each food waste fraction was weighed separately and its weight was recorded. The weight of each food waste type from all houses were calculated and divided by the total number of people in the houses to find its value in g per capita per day. The survey was conducted in winter season and mostly winter fruit (orange, apple, guava, banana, lemon and pineapple) and vegetables (cabbage, carrot, radish, cauliflower, radish pods and green chilies) were consumed in study area.

2.3 Nutritional estimation of food waste

Nutritional food waste estimation was done by comparing the values of each food waste item with food composition table for Pakistan (Hussain, 2001). From each food waste type, loss of energy, protein, lipids, fibers, carbohydrates, moisture, minerals {calcium (Ca), phosphorous (P), iron (Fe) zinc (Zn) and iodine (I)} and vitamins (vitamins A and C) were calculated. Each food waste type is compared with the given values of each food (one g) in food composition table for Pakistan (presented as supplementary data in Table 7).

2.4 Reasons for food waste

A face-to-face questionnaire survey was also conducted from the same households from where food waste was collected to know the reasons for various types of food waste. The questionnaire consisted of thirteen reasons and seven food types (fruits and vegetables, dairy, meat, cereals, egg, processes food and cooked food) along with the option of "no answer". Respondents were asked to tick the reason which they consider appropriate for the waste of that particular type of food.

Although respondents in the study area cooperated very well however few of them were reluctant to give information without the permission of male members of the family. Some respondents did not cooperate due to the extra burden of handling of food waste, unpleasant odor and superstitious believe of using their food waste for doing black magic. Some respondents think it a ridiculous activity and showed lack of attention due to their busy household activities.

2.5 Statistical analysis

Data was analyzed using descriptive statistics with SPSS software.

3 Results

3.1 Daily food waste generation

In the study area cooked food was being wasted from the households in high (35.01 g) amounts followed by vegetables (11.62 g) and fruits (9.78 g) while cereals (2.45 g) and dairy (1.98 g) per capita per day were wasted in lesser amount (Figure 2).

3.2 Nutritional estimation of food waste

Food waste results in waste of the nutrients present in the discarded foods. When flour is wasted, maximum amount of energy wasted (8.75 kcal), as it is major energy source for human body

(Table 1). Nutritional losses associated with cooked food are presented in Table 2. Maximum energy (11 kal) and protein (0.75 g) were wasted when roti and chicken were wasted respectively. Maximum moisture (3.97 g), lipids (0.94 g) and carbohydrates (2.53 g) per capita per day were lost with rice waste.

When nutritional loss estimation of vegetables was done (Table 3), onion was found to be the major energy wasting vegetable (1.13 kcal per capita per day) followed by carrot (1.02 kcal per capita per day) and cauliflower (0.43 kcal per capita per day). Maximum moisture loss was linked with carrot (2.27 g) followed by onion (2.14 g) and cauliflower (1.45 g) per capita per day. When nutritional losses of fruits were estimated in the study area (Table 4), it was found that maximum energy (2.2 kcal) and carbohydrate (0.54 g) losses per capita per day were associated with banana waste. Maximum moisture was being lost with the orange waste (3.45 g) per capita per day. Protein losses were less observed in fruits.

Nutritional loss estimation for dairy products revealed that yogurt waste contributed to loss of energy (0.71 g; 43%) and moisture (0.84 g; 51%) (Figure 3c). No fiber loss was associated with yogurt.

Nutritional losses due to food waste of all types have been shown in Figure 3e. Via the calculated nutritional losses of all food types, it is clear that food waste (all types) results in energy loss (54 kcal; 54%), moisture loss (30 g; 30%), protein (2.61 g; 3%), lipid (2.21 g; 2%), carbohydrate (10.58 g; 10%) and fiber (0.75 g; 1%) per capita per day. Energy loss was high in cereals (85 kcal; 79%) and cooked food (36.7 g; 59%), while low for fruit (5.31 kcal; 37%) and vegetables (2.95g; 25%). Similarly, moisture loss was high in fruits (7.52 g; 53%) and vegetables (8.15 g; 69%), while low in cereals (0.29 g; 3%) (Figure 3a, b and f). From all types of food waste major nutritional losses includes energy, moisture, carbohydrate and protein.

On the basis of Pakistan food basket (2100 kcal) fruit and vegetables waste govern major portion (21.40%) of daily requirement of fruit and vegetables while, cereals waste comprised of minor portion (0.82%) of daily requirement of cereals (Table 5). At household level 2.6% of total kcal (2100 kcal) requirement and 3.9% of daily protein requirement (66.8 g) was wasted per person per day in tehsil Kahror Pakka, Pakistan.

3.3 Causes of food waste at household level

In this section, respondents were asked to share their major reasons of wasting different types of food (Table 6). They were provided with the reasons observed commonly in routine life. The major reasons provided by the respondents for cooked food waste were that food looks bad (50%), misplanning of meal (40%) and improper cooking (36%). Processed food is considered a luxury item and is purchased when there is excess of money (47%) and mostly wasted due to unawareness regarding labeling dates (50%), and buying wrong package size (43.33%). Cereals were wasted due to incorrect storage (33.33%) and improper cooking (26.66%). Meat and poultry were wasted at household level as they were cooked too much (33.33%), purchased too much and misplanning of meal (26.66%). Buying wrong package size (30%), purchased too much (23.33%), not consumed in time (23.33%) and incorrect storage (23.33%) were the major reasons for dairy waste. Fruit and vegetables were mostly wasted when these were frozen or refrigerated too long (20%) and when served too much (16.67%).

4 Discussion

Household food waste generation depends on many factors like consumer attitude and behavior, socio-economic condition of the people, education level, and total number of person in household and eating preferences (Glanz, 2008; Parfitt et al., 2010). Cooked food waste was high while cereals and dairy waste was less in the study area. A study done in UK report higher fresh

vegetables and salad waste and lower meals or cooked food waste (Quested and Johnson, 2009). Fruit and vegetables were wasted more while cereals and dairy were wasted less in UK (DEFRA, 2010). In Philippines Sibrian et al., (2006) reported that milk and milk products were wasted more while meat, egg and nuts were wasted less at household and institutional level. Similarly, Thonissen, (2009) found more portion of dairy waste among different types of food waste in the Netherlands. In Turkey, fruits, vegetables and poultry waste was high while cereals and red meat waste was low (Pekcan et al., 2006). A study in South Africa revealed that fruit and vegetables losses were high while milk losses were low at household level (Oelofse and Nahmn, 2013). Food consumption habits, perishability of the produce, price and availability of the commodity influences food waste generation. In Netherlands milk is the cheapest commodity among other food items (Anonymous, 2018a) and might be the reason for more waste by the consumers. Similarly, in Turkey prices of red meat is high as compared to other commodities (Anonymous, 2018b) hence resulting in less red meat waste. Consumption of fruit, vegetables and poultry were high in Turkey which results in more food waste. Moreover fruit, vegetables and poultry are perishable commodities whereas cereals are non-perishable hence result in less food waste of cereals.

In United States of America 59 pounds of vegetables, 52 pounds of dairy products, and 41 pounds of meat, fish and poultry per person were wasted during 2010 (Buzby et al., 2014). Parfitt et al., (2010) reported that fruit and vegetables were wasted more, followed by bakery and dairy products, meat and fish. The types of food waste generation vary from area to area. The differences in types of food waste might be due to differences in food habits, which depend upon cultural norms, socio-economic condition of population and dietary preferences of different regions of the world (Trichopoulou et al., 2002). In this study fruit and vegetable losses were less

as compared to developed countries. This disparity in food habits might be due to better infrastructure (in terms of transportation and cool temperature storage) and lack of involvement of middle man in developed countries, results in low prices of fresh fruit and vegetables as compared to developing countries. Marketing of fresh produce in developed countries is very conducive and fruit and vegetables are purchased from supermarket with many sale offers whereas in less developed countries fruit and vegetables are purchased on daily basis or when required in small quantities and utilized fully by the household. Moreover, in developing countries cost of fruit and vegetables were higher (relative to their household income) than in developed countries which results in reduced consumption (Miller et al., 2016) and ultimately result in less fruit and vegetable waste.

Assessment of nutrition loss with food waste is very important to know, the type and extent of nutrients which are wasted with food waste and to provide awareness among the people to reduce waste of nutrient dense food which are necessary for human health. On an average, in this study total energy lost by all types of food is 54.42 kcal per capita per day. Similarly, the Food and Agricultural Organization (FAO) reported that in South and South East Asia 414 kcal per capita per day energy losses were associated with food losses from farm to fork. As compared to this, it was estimated in another study done in America that all food types (including added sugars and sweeteners) contribute 1,400 calories loss per capita per day (Hall et al., 2009). Lundqvist et al., (2008) reported that 1,400 kcal per capita per day were lost worldwide from farm to fork. However, Buzby et al., (2014) reported 789 kcal per capita per day of food waste at retail and consumer level in USA. In Turkey 215 kcal per capita per day was wasted by food waste (Pekcan, 2006). In this study energy loss (54.42 kcal) per capita per day is very low as compared to other countries. This could be due to differences in types and amount of food which

is wasted, method of food estimation and time and duration (season) of food estimation. As this study was done in winter season and due to low temperature food waste was low. Moreover our study comprised of primary data taken directly from household waste bins collected after 24 hours' time period. Whereas, in other studies mentioned above secondary data was used and food waste was calculated from all stakeholders (from farm to fork) of supply chain by using recall method or considering the difference between foods supplied to food consumed as food waste. In the current study it was found that energy losses were higher from cereals in case of cooked form as roti (11 kcal) and uncooked form as flour knead (8.75 kcal) per capita per day. Similar results were also reported in FAO (2011) study which revealed that 53% calories were lost with cereal waste.

Among various food categories maximum moisture loss was recorded with vegetables (8.15 g) and fruit (7.52 g) waste while minimum moisture loss was associated with cereals waste (0.29 g) per capita per day. Similarly Lipinski et al., (2013) reported that water loss was higher with fruit and vegetable waste while lower with cereals waste. Nutritional losses from all types of food waste include protein (2.61 g), lipids (2.21 g), carbohydrates (10.58 g) and fiber (0.75 g) per capita per day. In US food supply during 2012 food wasted at the retail and consumer levels contained energy (1,217 kcal), protein (33 g), dietary fiber (5.9 g), vitamin D (1.7 µg), calcium (286 mg), and potassium (880 mg) per capita per day (Spiker et al., 2017). Whereas, in UK Copper et al., (2018) estimated that household food waste comprised of energy (326 kcal), protein (10.9 g), fiber (3.4 g), µg vitamin D (0.8), calcium (120 mg), and potassium (486 mg). Our estimates are lower than spiker et al., (2017) as they consider both retailer and consumer level food waste however, our study comprised of only household food waste data. The

discrepancy with the results of Copper et al., (2018) is likely due to differences in eating habits of two countries.

In this study minerals and vitamin losses through food waste (including all types of food) revealed that loss of β-carotene was higher (61%) followed by vitamin A (21%) and P (8%) while riboflavin and thiamin losses were very low. Contrary to our findings Cooper et al., (2018) reported higher losses of vitamin B_{12} (160 nutrient days per capita per year), vitamin C (140 nutrient days per capita per year, and) and thiamin (130 nutrient days per capita per year). In cereals P (72%), fruit and vegetables β-carotene (64% and 71% respectively) and in dairy Ca (47%) and P (40%) losses were found higher whereas riboflavin and thiamin losses were almost negligible. In fruit and vegetable supply chain from farm to fork vitamin A and C losses were highest in Industrialized Asia (784 R/day and 90 mg/day respectively) and lowest in Sub Sahara and Africa (135 RE/day and 26mg/day respectively) (Serafini et al., 2015). In Norway vitamin A losses in the fruit and vegetable supply chain were 280.3 kgRE per year (fruit 32 kgRE per year and vegetables 247.4 kgRE per year) and in Kenya were 338.8 kgRE per year (Serafini et al., 2015). So, it is clear that all food waste is contributing to nutritional losses depending on the food composition. By reducing the food losses, nutritional losses can be reduced.

Finding the reason for food waste is of the utmost important to reduce food disposal. In the study area most common reason for cooked food disposal was: food looked bad, misplanning of meal and improper cooking. Similar reasons were also reported for food waste irrespective of its types in Morocco by Abouabdillah et al., (2015), in United Kingdom by Parfitt et al., (2010) and in Vienna and Lower Austria by Glanz (2008). According to a survey conducted by WRAP (2009) for households in the UK, 41% of the food waste occurred because too much was cooked or served, and 54% of waste was because the food was not used in time. Segre (2013), from a

cluster analysis of an open survey, distinguished seven types of causes of consumer attitudes leading to waste, linked to food preferences, food consumption habits, and to different representations of the reasons why they waste. With the food loss, there is also a significant loss of resources which are involved in production, transport and storage. In nature the resources like energy, fresh water, land and agricultural inputs are limited, therefore they should be used sustainably and efficiently. The cost of food to the consumers could bring down by improving the efficiency of food value chain and hence by the way the excess for low income households could be increased (Gustavsson et al., 2011).

Among processed food the main reason for food waste were labeling date and wrong package size. Similar reasons were also provided by many researchers in several other countries (Aschemann-Witzel et al., 2015; Buzby and Hyman, 2012). There are no strict rules and check and balance for marketing expired products in a small city like Kahror Pakka. These products are unconsciously or deliberately sold by the shopkeeper. People purchased these products due to lack of awareness regarding produce labeling date and hence result in more food waste.

Reasons provided by the respondents regarding fruit and vegetables waste at household level were: not used in time, frozen or refrigerated too long, served too much and looked bad. Similar reasons were also reported in their study by Jorissen et al., (2015) in Germany and Ramukhwatho et al., (2014) in South Africa. Fruit and vegetables were purchased in large amounts and people were unaware about their proper storage temperature and mostly store chilling sensitive produce in refrigerator/freezer or kept fruit and vegetables on shelf for longer period of time than recommended, which results in more losses and waste.

Conclusion

This study has provided preliminary information about the extent of food and nutritional waste and the behavior of respondents which causes these wastes at household level. In study area, cooked food was wasted more due to misplanning of meals and the food's bad smell. Moisture, β-carotene and vitamin A losses were more from fruit and vegetables, while energy losses were higher from cereals. Respondents in study area were unaware of labeling date and proper storage methods of food items. Properly addressing the reasons behind food waste can reduce food waste and improve its availability to humans, save money and prevents wastage of natural resources used in production of food. Reducing food waste could help people acquire the food they need to meet their daily recommended intake. Food and nutrition waste assessment can help to develop policies and tools that provide awareness regarding nutrition losses associated with food waste by modifying handling and storage practices, food consumption behavior, portion and packaging size. Further research with bigger sample size is a prerequisite to getting a better idea about food waste at household level and saluting the problem.

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Table 1: Nutritional losses associated with the cereals waste from various households in tehsil Kahror Pakka

Type (g per capita per day)	Energy (kcal)	Moisture (g)	Protein (g)	Lipid (g)	Carb. (g)	Fiber (g)	Ca	P	Fe	Zn	I	Th.	Rib	Niacin	Vit.C	β-cart	Vit.A	Chol.
Flour knead (2.45)	8.75	0.29	0.24	0.02	1.83	0.02	0.78	2.65	0.11	0.07	0	0.0074	0.0015	0.044	0	0	0	0

** Nutrients present in 1g of cereals are presented in supplementary material*
Ca: Calcium; Carb: Carbohydrates; Chol: Cholesterol; P: Phosphorous; Fe: Iron; Zn: Zinc; I: Iodine; Th: Thiamin; Rib: Riboflavin; Vit: Vitamin;

Table 2: Nutritional losses associated with the cooked food waste from different households in tehsil Kahror Pakka

Type (g per capita per day)	Energy (kcal)	Moisture (g)	Protein (g)	Lipid (g)	Carb. (g)	Fiber (g)	Ca	P	Fe	Zn	I	Th.	Rib	Niacin	Vit.C	β-cart	Vit.A	Chol.
Cauliflower (0.24)	0.06	0.22	0.004	0	0.01	0.002	0.06	0.10	0.002	0.00072		0.00017	0.00017	0.00096	0.12	0.13	0.005	0
Daal (mung) (2.31)	3.6	1.44	0.231	0	0.51	0.16	1.50	1.94	0.076	0.046		0.0088	0.0046	0.079	0.42	1.62	0	0
Chicken (4.17)	7.8	2.88	0.75	0.75	0	0	0.63	7.80	0.08	0.063	2.79	0.00334	0.00667	0.32	0	1.75	0.667	2.91
Omelet egg (0.16)	0.24	0.11	0.01	0.01	0.001	0	0.086	0.34	0.004	0.002		0.00016	0.00046	0.00016	0	0.36	0.31	0.68
Mustard leaves (0.36)	0.19	0.31	0.01	0.001	0.03	0	0.62	0.19	0.032	-	-	0.00022	0.0005	0.0018	0.144	5.83	3.80	0
Kidney beans (0.07)	0.12	0.04	0	0	0.01	0	0.03	0.12	0.001	0.002	0	0.00032	0.000196	0.00161	0.0014	0.04	0.0084	0
Meat (1.480)	2.43	1.06	0.3	0.17	0	0	0.15	2.41	0.033	0.067		0.00237	0.00266	0.067	0	0	0	1.24
Potatoes (1.47)	1.22	1.13	0.02	0	0.28	0.01	0.43	0.69	0.010	0.003	1.20	0.00074	0.00044	0.0044	0.147	0.13	0	0
Kachnar (0.32)	0.17	0.26	0.001	0.002	0.04	0.003	0.18	0.17	0.017			0.000064	0.00032	0.0044	0.029	0	1.40	0
Rice (7.59)	2.03	3.97	0.33	0.94	2.53	0.05	1.21	4.93	0.061	0.11	0	0.00152	0	0.038	0	0	0	0
Roti (4.25)	11	1.31	0.34	0.05	2.42	0.034	3.44	2.38	0.24	0.085		0	0	0	0	0	0	0
Nan (0.91)	3.32	0.09	0.09	0.009	0.67	0.009	0.31	2.73	0.030	0.020	0	0.00255	0.00082	0	0	0	0	0
Radish pods (mongra) (0.67)	0.16	0.6	0.01	0.001	0.02	0.004	1.82	0.67	0.064	0	0	0.00119	0.00373	0.016	0.850	0	0	0
Kheer (1.39)	3.05	0.07	0.04	0.2	0.25	0.004	2.08	2.50	0.042	0	0	0	0	0	0	0	0	0
Halwa (0.32)	1.31	0.07	0.01	0	0.13	0.294	0.48	0	0.004	0	0	0	0	0.0064	0	0	0	0

** Nutrients present in 1g of cooked food (each type) are presented in supplementary material*
Ca: Calcium; Carb: Carbohydrates; P: Phosphorous; Fe: Iron; Zn: Zinc; I: Iodine; Th: Thiamin; Rib: Riboflavin; Vit: Vitamin; Chol: Cholesterol

Table 3: Nutritional losses associated with the vegetables waste from various households in tehsil Kahror Pakka

Type (g per capita per day)	Energy (kcal)	Moisture (g)	Protein (g)	Lipid (g)	Carb. (g)	Fiber (g)	Ca	P	Fe	Zn	I	Th.	Rib	Niacin	Vit.C	β-cart	Vit.A	Chol.
Green Chilies (0.42)	0.1	0.39	0.005	0.001	0.03	0.008	0.63	0	0.0046	0		0	0	0.0084	0	0	0	0
Cucumber (0.47)	0.07	0.44	0.003	0	0.01	0.002	0.085	0.113	0.0024	0.00094		0.00014	0.00019	0.0014	0.113	0.12	0.033	0
Radish pods (mongra) (0.86)	0.21	0.78	0.01	0.001	0.04	0.005	1.05	0.39	0.037	0	0	0.00069	0.0022	0.0095	0.490	0	0	0
Cauliflower (1.57)	0.43	1.45	0.02	0.003	0.07	0.01	0.39	0.68	0.013	0.0047		0.0011	0.0011	0.0063	0.754	0.86	0.031	0
Tomatoes (0.18)	0.03	0.17	0.001	0	0.01	0	0.025	0.049	0.0013	0.0002	0.018	0.00013	0.000072	0.0009	0.041	0.76	0.112	0
Cabbage (1.47)	0.03	1.35	0.02	0.003	0.08	0.01	0.76	0.66	0.0074	0.0029		0.00088	0.00074	0.0044	0.84	3.53	0.191	0
Carrot (2.76)	1.02	2.27	0.02	0.005	0.26	0.01	1.16	0.66	0.0414	0.0055	0.221	0.00138	0.0014	0.0193	0.28	243.87	77.64	0
Radish (1.16)	0.001	1.07	0.01	0.001	0.05	0.008	0.38	0.32	0.013	0.0035		0.00035	0.00035	0.0035	0.30	0.046	10.58	0
Onion (2.57)	1.13	2.14	0.04	0.005	0.26	0.02	0.745	1.21	0.018	0.0051	2.11	0.0013	0.00077	0.0077	0.26	0.23	0	0

**Nutrients present in 1g of vegetables (each type) are presented in supplementary material*
Ca: Calcium; Carb: Carbohydrates; P: Phosphorous; Fe: Iron; Zn: Zinc; I: Iodine; Th: Thiamin; Rib: Riboflavin; Vit: Vitamin; Chol: Cholesterol

Table 4: Nutritional losses associated with the fruits waste from various households in tehsil Kahror Pakka

Type (g per capita per day)	Energy (kcal)	Moisture (g)	Protein (g)	Lipid (g)	Carb.(g)	Fiber (g)	Ca	P	Fe	Zn	I	Th.	Rib	Niacin	Vit.C	β-cart	Vit.A	Chol.
Orange (3.94)	1.69	3.45	0.03	0.007	0.39	0.03	0.71	0.71	0.02	0.0039	0.71	0.0028	0.0012	0.016	1.69	11.82	0.83	0
Apple (0.52)	0.29	0.44	0.002	0.001	0.07	0.004	0.06	0.05	0.003	0.00052	0.042	0.00016	0.00016	0.001	0.042	0.203	0.03	0
Guava (0.85)	0.62	0.67	0.008	0.003	0.13	0.04	0.17	0.22	0.008	0.0017		0.0004	0.0006	0.0085	0.018	1.36	0.67	0
Bananas (2.30)	2.2	1.69	0.02	0.009	0.54	0.01	0.28	0.69	0.016	0.0046		0.0007	0.0012	0.0138	0.23	2.25	0.184	0
Pineapple (0.13)	0.05	0.11	0	0	0.01	0	0.02	0.02	0.0009	0.00013		0.00008	0.00004	0.0004	0.032	0.023	0.003	0
Lemons (1.53)	0.46	1.16	0.009	0.009	0.11	0.005	0.55	0.29	0.0061	0.0015		0.0006	0.00031	0.0015	0.796	0.214	0.046	0

**Nutrients present in 1g of fruit (each type) are presented in supplementary material*
Ca: Calcium; Carb: Carbohydrates; P: Phosphorous; Fe: Iron; Zn: Zinc; I: Iodine; Th: Thiamin; Rib: Riboflavin; Vit: Vitamin; Chol: Cholesterol

Table 5: Food waste (%) compared to the Pakistan daily average total consumption

Food items, nutrient and calories	*Daily requirement	Food waste	Food waste of total consumption per person
Fruits and vegetables	100 g	21.405 g per person per day	21.4 %
Dairy	150 g	1.98 g per person per day	1.32 %
Cereals (wheat)	300 g	2.45 g per person per day	0.82 %
Protein	66.8 g	2.61 g per person per day	3.9 %
Calories	2100 kcal	54.42 kcal	2.6 %

***** Hussain, (2001)

Table 6: Reasons (%) provided by the respondents regarding their food waste

Reasons		Fruits and vegetables	Dairy	Meat	Cereals	Egg	Processed food	Cooked food	No answer
Buying	Purchased too much	7	23	27	7	3	33	0	0
	Wrong package size	0	30	13	10	0	43	3	0
Cooking	Misplaning of meal	10	13	27	7	3	0	40	0
	Cooked too much	10	13	33	13	7	3	20	0
	Cooked improperly	10	3	7	27	7	10	36	0
Consumption	Smell moldy	3.	7	13	7	17	30	23	0
	Looked bad	10	10	3	17	3	7	50	0
	Not consumed in time	20	23	13	0	3	13	27	0
	Served too much	17	7	23	7	7	33	7	0
Storage	Incorrect storage	0	23	7	33	3	30	0	3
	Date labeling	0	13	13	7	10	50	0	7
	Freeze long	20	7	13	17	13	13	17	3
Other	Excess of money	0	3.	33	3	7	47	3	0

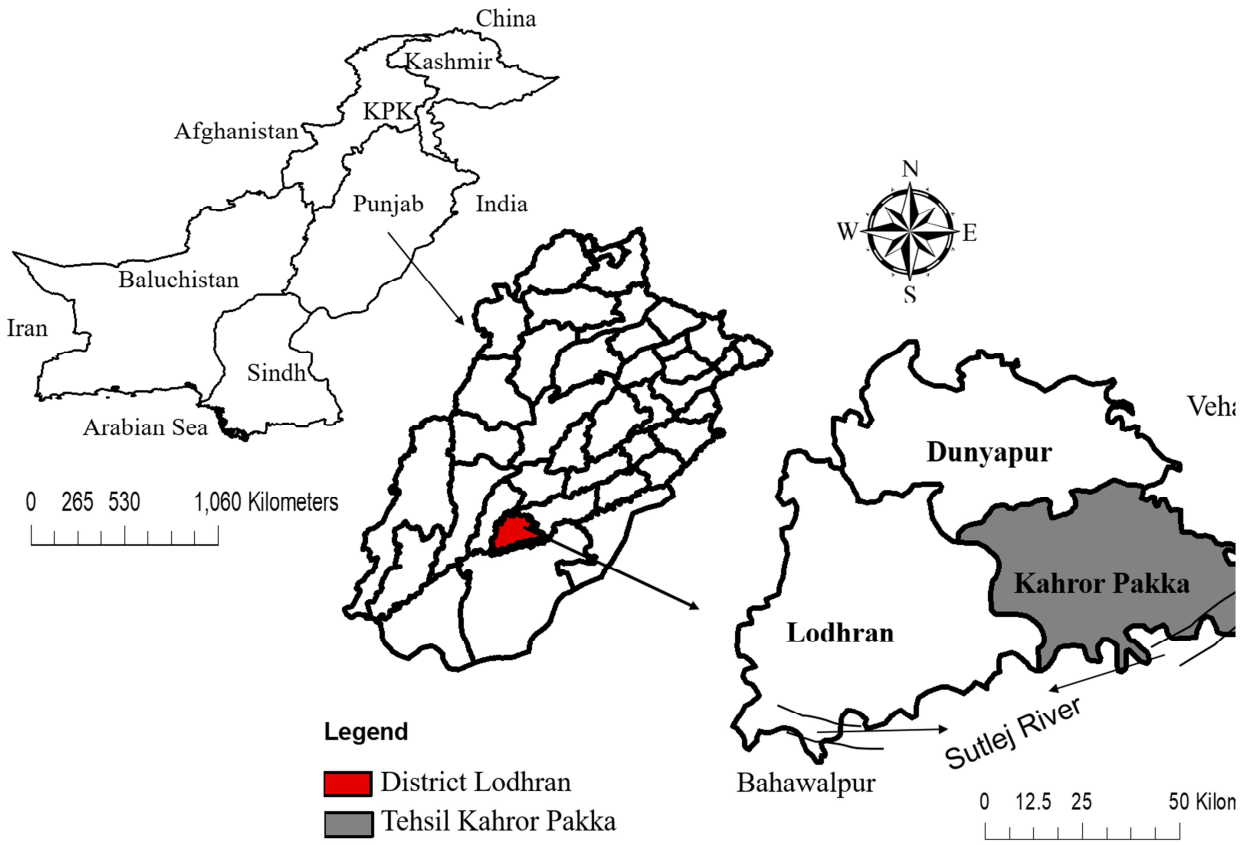

Figure 1 Map of tehsil Kahror Pakka, Punjab, Pakistan

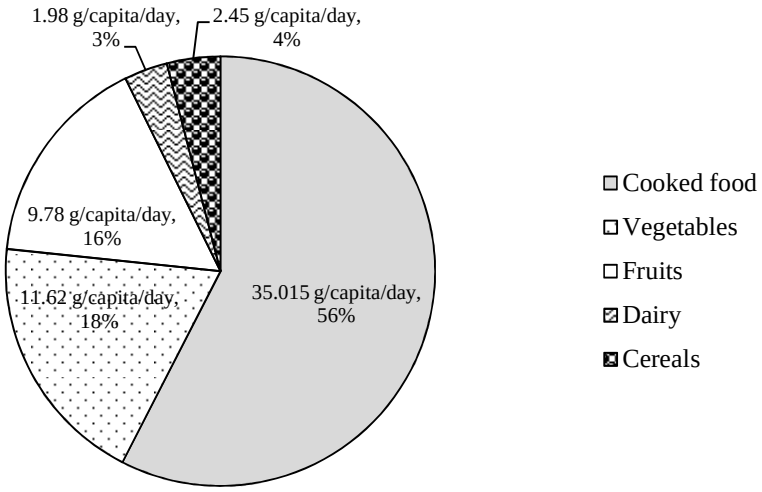

Figure 2 Food waste generation (g per capita per day) from tehsil Kahror Pakka, Pakistan

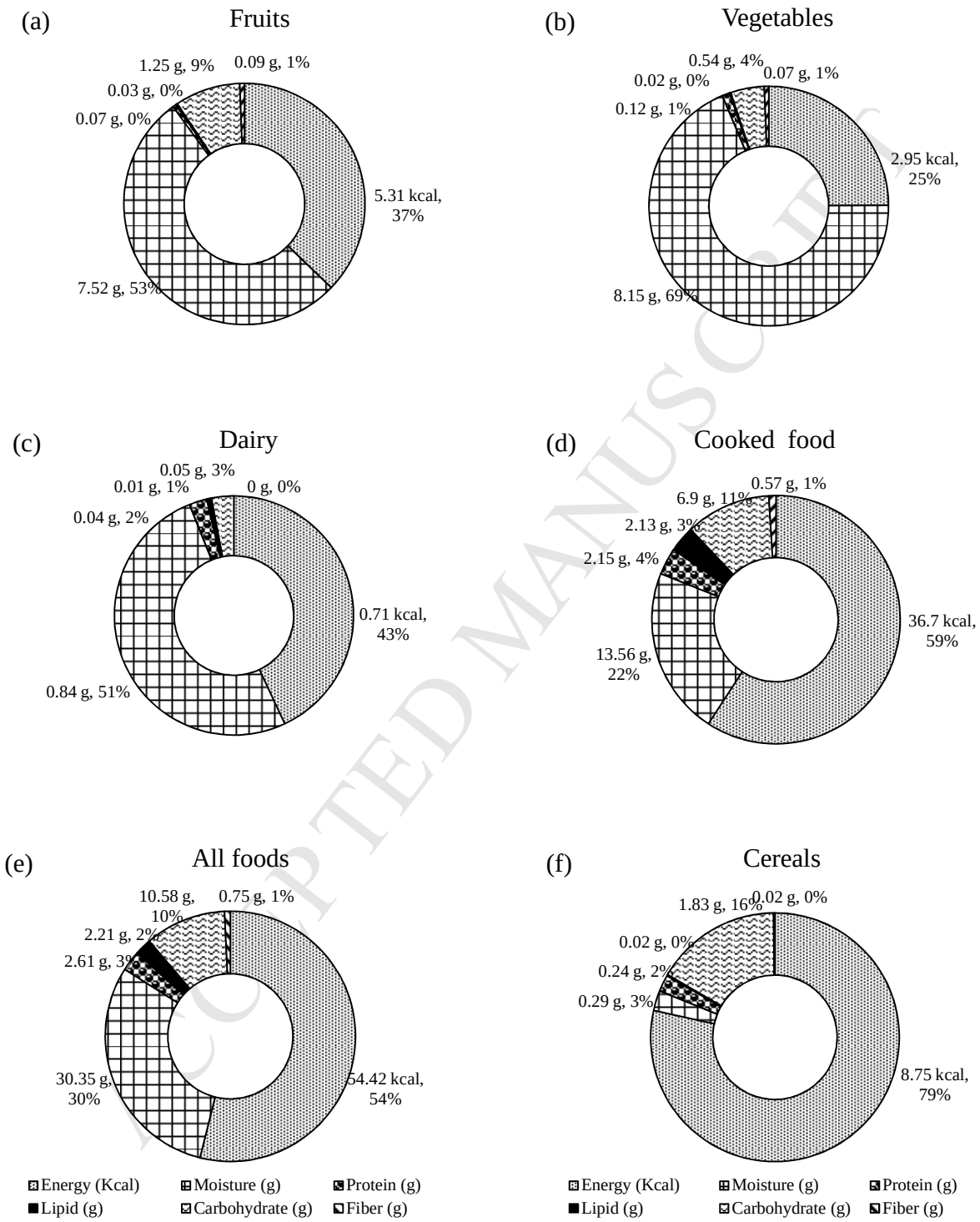

Figure 3 Nutritional losses from food waste (a) fruits, (b) vegetables, (c) dairy, (d) cooked food (e) all foods and (f) cereals at tehsil Kahror Pakka Pakistan

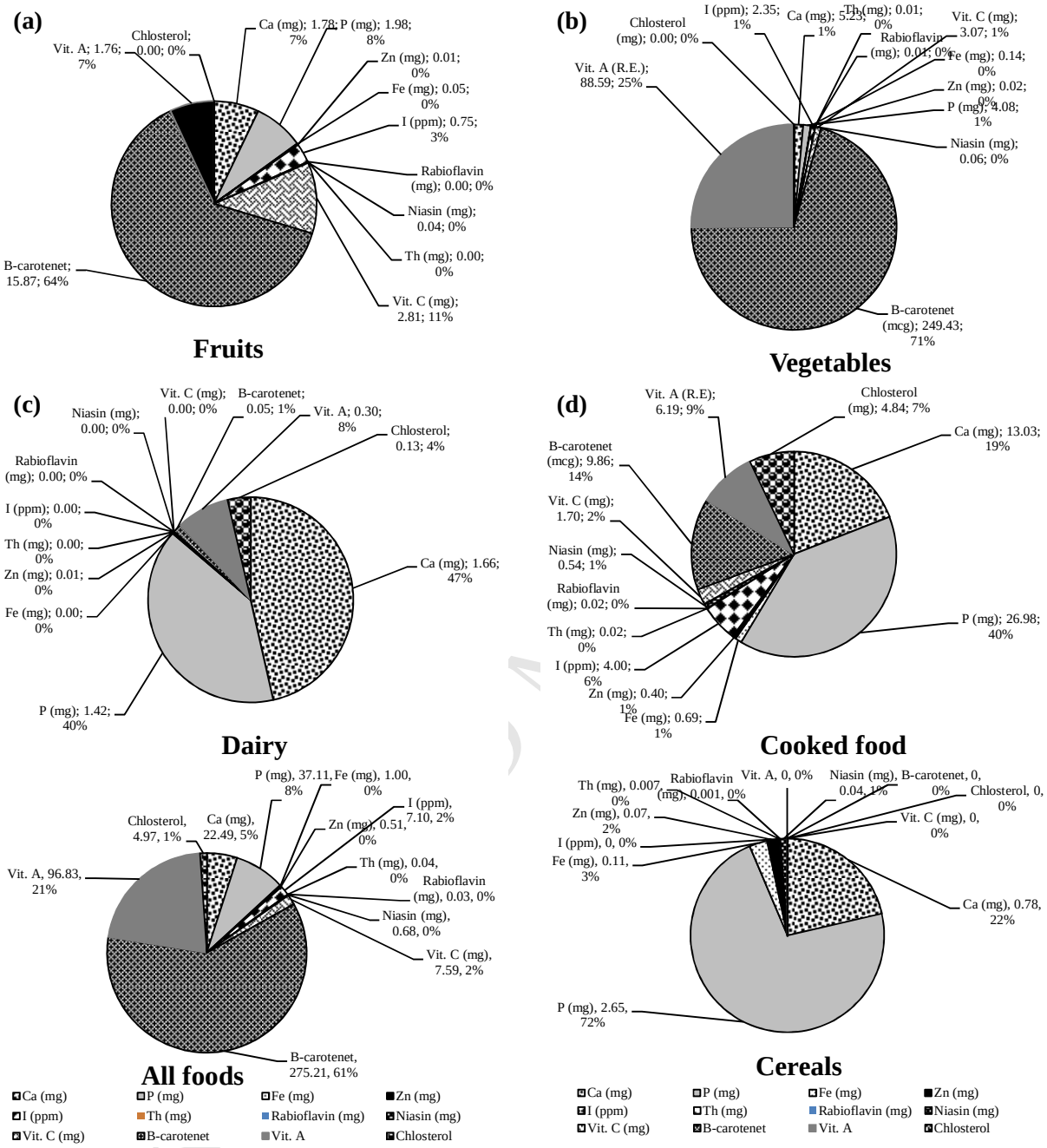

Figure 4 Nutritional losses from food waste (a) fruits, (b) vegetables, (c) dairy, (d) cooked food (e) all foods and (f) cereals at tehsil Kahror Pakka Pakistan

Supplementary material

Table 7 Nutritional value of various food types (1 g) adopted from food composition table for Pakistan 2001 (Husain 2001)

	Energy (kcal)	Moisture (g)	Protein (g)	Lipid (g)	Carb.(g)	Fiber (g)	Ca	P	Fe	Zn	I	Th.	Rib	Niacin	Vit.C	β-cart	Vit.A	Chol.
Cereals																		
Flour knead	3.57	0.12	0.1	0.01	0.75	0.009	0.32	1.08	0.045	0.029	-	0.003	0.0006	0.018	0	0	0	0
Cooked food																		
Cauliflower	0.27	0.927	0.018	0.002	0.048	0.007	0.25	0.43	0.008	0.003	-	0.0007	0.0007	0.004	0.48	0.55	0.02	0
Daal mung	1.58	0.625	0.106	0.01	0.225	0.07	0.65	0.84	0.033	0.002	-	0.0038	0.002	0.034	0.18	0.70	0	0
Chicken	1.87	0.69	0.18	0.18	0	0	0.15	1.87	.0019	0.015	0.67	0.0008	0.0016	0.076	0	0.42	0.16	0.70
Omlete egg	1.55	0.722	0.122	0.112	0.008	0	0.54	2.10	0.027	0.011	-	0.001	0.0029	0.001	0	2.24	1.91	4.25
Mustard leaves	0.55	0.868	0.037	0.004	0.073	0.011	1.72	0.54	0.089	-	-	0.0006	0.0015	0.005	0.40	16.20	10.56	0
Kidney beans	1.75	0.585	0.142	0.012	0.209	0.027	0.43	1.7	0.017	0.026	0	0.0046	0.0028	0.023	0.02	0.54	0.12	0
Meat	1.64	0.715	0.196	0.112	0.001	0	0.10	1.63	0.022	0.045	-	0.0016	0.0018	0.045	0	0	0	0.84
Potatoes	0.83	0.771	0.019	0.002	0.193	0.004	0.29	0.47	0.007	0.002	0.82	0.0005	0.0003	0.003	0.10	0.09	0	0
Kachnar	0.56	0.821	0.022	0.005	0.13	0.01	0.56	0.54	0.053	-	-	0.0002	0.001	0.014	0.09	0	4.37	0
Rice	0.268	0.523	0.044	0.124	0.334	0.006	0.16	0.65	0.008	0.015	0	0.0002	0	0.005	0	0	0	0
Roti	2.59	0.3	0.08	0.012	0.57	0.008	0.81	0.56	0.056	0.02	-	0	0	0	0	0	0	0
Nan	3.69	0.1	0.1	0.01	0.75	0.01	0.34	3	0.033	0.022		0.0028	0.0009	0	0	0	0	0
Radish pods (mongra)	0.25	0.9	0.02	0.002	0.04	0.006	1.22	0.45	0.043	0	0	0.0008	0.0025	0.011	0.57	0	0	0
Kheer	2.2	0.05	0.03	0.15	0.18	0.003	1.5	1.8	0.03	0	0	0	0	0	0	0	0	0
Halwa	4.1	0.22	0.05	0	0.42	0.92	1.50		0.011					0.002	0	0	0	0
Vegetables																		
Green Chilies	0.25	0.923	0.013	0.003	0.093	0.021	1.50		0.011					0.002	0	0	0	0
Cucumber	0.016	0.951	0.008	0.001	0.032	0.005	0.18	0.24	0.005	0.002	-	0.0003	0.0004	0.003	0.24	0.26	0.07	0

Radish pods (mongra)	0.25	0.905	0.02	0.002	0.046	0.006	1.821	0.672	0.0642	0	0	0.0012	0.0037	0.0164	0.851	0	0	0
Cauliflower	0.27	0.927	0.018	0.002	0.048	0.007	0.25	0.43	0.008	0.003	-	0.0007	0.0007	0.004	0.48	0.55	0.02	0
Tomatoes	0.21	0.935	0.011	0.002	0.041	0.005	0.14	0.27	0.007	0.001	0.10	0.0007	0.0004	0.005	0.23	4.24	0.62	0
Cabbage	0.023	0.92	0.015	0.002	0.048	0.009	0.52	0.45	0.005	0.002	-	0.0006	0.0005	0.003	0.57	2.40	0.13	0
Carrot	0.37	0.825	0.009	0.002	0.092	0.007	0.42	0.24	0.015	0.002	0.08	0.0005	0.0005	0.007	0.10	88.36	28.13	0
Radish	0.23	0.928	0.012	0.001	0.046	0.007	0.33	0.28	0.11	0.003	-	0.0003	0.0003	0.003	0.26	0.04	9.12	0
Onion	0.44	0.831	0.014	0.002	0.098	0.007	0.29	0.47	0.007	0.002	0.82	0.0005	0.0003	0.003	0.10	0.09	0	0
Fruits																		
Orange	0.43	0.878	0.008	0.002	0.1	0.008	0.18	0.18	0.005	0.001	0.18	0.0007	0.0003	0.004	0.43	3.00	0.21	0
Apple	0.57	0.847	0.004	0.003	0.139	0.008	0.11	0.10	0.006	0.001	0.08	0.0003	0.0003	0.002	0.08	0.39	0.05	0
Guava	0.73	0.799	0.01	0.004	0.153	0.056	0.20	0.26	0.009	0.002	-	0.0005	0.0007	0.01	0.0217	1.60	0.79	0
Banana	0.96	0.735	0.013	0.004	0.236	0.005	0.12	0.30	0.007	0.002	-	0.0003	0.0005	0.006	0.10	0.98	0.08	0
Pineapple	0.45	0.87	0.007	0.002	0.11	0.005	0.15	0.16	0.007	0.001	-	0.0006	0.0003	0.003	0.25	0.18	0.02	0
Lemon	0.3	0.894	0.007	0.007	0.085	0.007	0.36	0.19	0.004	0.001	-	0.0004	0.0002	0.001	0.52	0.14	0.03	0
Dairy																		
Yogurt	0.71	0.835	0.035	0.012	0.053	0	1.66	1.42	0.004	0.006	-	0.0003	0.0014	0.001	0	0.05	0.30	0.13

Ca: Calcium; Carb: Carbohydrates; P: Phosphorous; Fe: Iron; Zn: Zinc; I: Iodine; Th: Thiamin; Rib: Riboflavin; Vit: Vitamin; Chol: Cholesterol