



**Addis Ababa University**

**College of Natural and Computational Sciences**

**Center for Food Science and Nutrition**

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**Macronutrient Loss Associated with Food Waste in Café of Addis Ababa  
Science and Technology University (AASTU)**

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**MSc Thesis Submitted to the Center for Food Science and Nutrition,  
Community Nutrition stream**

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**Addis Ababa**

## DECLARATION

I hereby declare that this thesis entitled “**Macro-Nutrient Loss Associated with Food Waste in Café’ and Food Court of Addis Ababa Science and Technology University (AASTU)**” is my original work; furthermore, this study has not been presented in any other university or institution for the award of degree or diploma. All sources of materials used for this thesis proposal have to be duly acknowledged.

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As Master’s Research Advisors, I hereby certify that I have read and evaluated this MSc thesis proposal prepared under my guidance by Getnet entitled: “**Macro-Nutrient Loss That Associate with Food Wastes in Café’ and Food Court of Addis Ababa Science and Technology University (AASTU)**”.

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## **ACRONYMS**

FAO----- Food and Agriculture Organization  
WHO-----World Health Organization  
UN-----United Nation  
WRAP----- Waste & Resources Action Program  
NGO----- Non-Governmental Organization  
FLW-----Food Lose and Waste  
WFP- -----World Food Program  
RDA----- Recommended daily Allowance  
AI----- Adequate Intake  
EAR----- Estimated Average Requirement  
AMDR----- Average Macronutrient Distribution Range  
CFSVA -----Comprehensive Food Security and Vulnerability Analysis  
SDG----- Sustainable developmental goal  
AASTU----- Addis Ababa Science and Technology University  
EHNRI----- Ethiopian Health and Nutrition Research Institute  
CSR----- Corporate Social Responsibility  
GHG----- Green House Gases

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## ABSTRACT

**Background:** Various researchers have reported that one third of food that we produced were wasted per capital per year in the globe which can cover daily recommended intake of millions people. Previous study showed that wasted food in consumer level contains between 1,249 and 1,400 kcal per capita per day, but there is no study on energy and macronutrient loss in Ethiopia café, restaurant and mass catering service provider that embedded along with wasted foods.

**Objective:** To assess the prevalence of macronutrient loss that are embedded in wasted food in the catering service provider and contextualize the amount of nutrient loss in terms of gaps between current and recommended intakes

**Methods:** Institution based cross-sectional study conducted at Addis Ababa Science and Technology University. A representative sample size of 350 plates (consumers) were-selected to participate in the study. Simple random sampling technique used to select the study participants. Randomly selected male and female students considered in the study. Interviewer administered questionnaire for sociodemographic and direct weight measurements used to collect the data. Crude food waste (plate leftover) data converted to its equivalent macronutrient loss based on local food composition data and the results of laboratory-based analysis of nutrient composition of the food. The collected data entered and processed by SPSS, to analyze the descriptive and inferential statistical analysis. Mean comparison analysis was used after setting statistical significance at  $\alpha= 0.05$ . Independent T-test analysis conducted to compare the significance different between male and female mean values.

**Results:** three hundred fifty adults took part in the study with a response rate of 91.9 %, of whom 320 (91.9%) were AASTU café' consumers. The prevalence of food waste was 31.7 %, 46.1 %, 26.9 and 21.8 % for Injera, bread, cooked pea and lentils, respectively; while it was 40% for vegetables (cooked cabbage). The wasted food contained equivalent number of loss: energy 13538 MJ, 107 protein, 517 Carbohydrate, 71 total Fat, 2,104 dietary fiber Kg per capita per day. There were significant difference in Carbohydrate and energy equivalent loss ( $P<0.05$ ); female plate loss (M= 175.8, SD= 37.5) was higher than male (M=119.7, SD= 34.0) and energy equivalent loss for female (M= 897.9, SD= 203) was lower than male (M=952.9, SD= 188). Mean energy loss could cover on average 46.5 % energy (Kcal/d) of adult female and male

RDA. Carbohydrate equivalent loss (g/capita/d) covered on average 65.5% of the lower range of AMDR (45-65 %Energy). Protein equivalent loss embedded in the food waste also could cover on average 46% of Protein EAR (66 g/d) for adult age female and male. Using carbohydrate as an example, 517g carbohydrate loss mean that 55% more of the Recommended Dietary Allowance for adult woman. This is equivalent to the carbohydrate Recommended Dietary Allowance (RDA) for an average 1870 adults and the amount of wasted macronutrients are equivalent to cover the gap for 3738 adults' food energy requirement per day.

**Conclusion and recommendation:** This was the first study to document the loss of macronutrients from selected common staple food waste in the Institution based food supply. Even if only a small portion of discarded food can practically be made obtainable for human consumption, efforts to redistribute surplus foods where appropriate and prevent food waste in the first place could increase the availability of nutrients for needy, while saving money and natural resources.

Key words: Food Loss and waste, Macronutrient

## **1. INTRODUCTION**

In different parts of the globe nutrition experts show their efforts in fighting food loss and wastes within their respected study areas. Facts sheets and research studies indicated that one third of the food we grew around the world is lost or wasted due to several reason (FAO, 2017). According to Food and Agriculture organization (FAO) ‘Save Food Global initiative on food loss and waste reduction report’, 1.3 billion tons of food, which could feed 2billion people, go to waste every year (FAO, 2015). In Ethiopia, this issue not raised as a problem or documented. Personal exercise and observation in Addis Ababa clearly showed that, people search for discarded food from vegetable and fruit market “Atekelt Tera” and buy leftover food from hotels, “Gursha” that contributes to their daily food energy intake. These phenomena prompted me to conduct a study on the avoidable loss and food wastes in the consumer level in the food supply chain system.

The study mainly focus on the nutritional values of wasted foods in terms of calories and macronutrients. The research does not aim to give a comprehensive picture of all food service sector, but instead to offer opportunities to assess how food production and consumption affect food waste generation and propose implementable prevention method based on the findings. The research area cover determination of portion size and macro nutrient loss generation at consumer level or consumption /plate leftover/. It not includes waste collection and final disposal at the landfill or other waste treatment facilities.

### **1.1 BACKGROUND OF THE STUDY**

Loss and waste of foods management needs to be an urgent ‘new’ priority for improving diets and nutrition in Africa including Ethiopia. Research studies showed that in African, Sub-Saharan countries food loss and waste exists 15% was due to poor production system, 15% due to retail level distribution gap and 5% due to consumer level waste (Global Panel on Agriculture and Food Systems for Nutrition, 2018). In South Africa, from the total quantity of food waste (percentage, by mass) the following relative contribution of food waste quantities in each food group was registered. Cereals 26%, roots and tubers 9%, pulses 4% and fruits and vegetables 44% (Global Panel on Agriculture and Food Systems for Nutrition, 2018).The above numbers have remarkable implications that could explain briefly about food lost and waste in the poor continent Africa. In Ethiopia poverty and food insecurity are widespread, and millions of Ethiopians are poor and inadequately fed. Approximately 20.5% of households are

estimated to be food insecure in 2016 (WFP and Central Statistical Agency, 2016), of which Amhara region account for 36.1%, 20% Oromia, Afar 26.1%, and Tigray 24.7% and also 25.3 % food insecurity in individual level (WFP and CSA, 2016). Based on the above data we can say that there are approximately 26 million food insecure people in Ethiopia. The same study also indicated that 13.9% of urban households were food insecure (WFP and Central Statistical Agency, 2016). On top of this situation with the additional occurrences of drought and other food security shocks, food loss and waste in different areas of food service sector contribute share to the negative impacts. There are no enough researches that shows how macronutrient loss within the food loss and waste contribute to the macronutrient malnutrition and food insecurity in the country. There are various international research and publications that associate macronutrient loss with food waste (Marie Spiker, 2016) that latter has significant value in the nutrition, food insecurity, economic and environmental impacts (Thyberg, 2016).

This research appeared so far to be an area with a good example to take an initiative to study macro nutrient loss along with food loss and waste across different areas in the retail/food service pathways and estimate average requirements based on current portion size as a means of preventive method. Even though loss happen in manufacturing sector, during post-harvest area and other retail and food service providers. Such as hotels and restaurants (Clément and Deloitte, 2016). Less or no research has been made to quantify the amount of macro nutrient loss that exist along with the food wastes in Ethiopia and standard portion size for female and male at different ages. However, several researches showed the prevalence of macronutrient malnutrition. For example, in the study conducted by WFP (Ethiopian Office) and Central Statistical Agency of Ethiopia indicated that, there was 25.4% stunting (protein energy malnutrition) in urban area and 14.6% in Addis Ababa in 2016. Also indicated that food energy consumption holds 26.7% of household's and food insecure 11.5% households in Addis Ababa (WFP and Central Statistical Agency, 2019). Effective food/nutrient utilization or controlling nutrient flow path based on its concentration or availability may reduce the problem significantly.

To date, it was difficult to find related studies conducted in Ethiopia that quantifies and assess macronutrient loss along with food wastes from any spot in the food supply chain. We can say that with other food loss and waste spots like loss in while transporting, poor storage, home leftover, food loss and waste in Hospitals and university retail in general has its own impact on

macronutrient insecurity along with food security. This research will calculate the nutritional value of food wasted at the university levels in the canteen food supply, and contextualize the quantity of macro nutrient loss in terms of gaps between current and recommended intakes and suggest portion size after quantifying current energy intake. In addition, to indicate the direction of macro nutrient flow by determining portion size of the consumer and propose possible macronutrient loss prevention methods. Reducing food wastes and implementing consumer behavior can be beneficiary for the food catering for various reasons. Firstly, in doing this, macronutrient loss along with food wastes will be preserved and redirected to prevent macro nutrient malnutrition. Also, provide scientific data that shows how much of purchased macronutrient/foods/ are consumed and how much loss will or waste which latter use as viewpoints for further studies. Secondly, saving foods from loss and waste means saving macro and micronutrients, which will, used for human consumption (Marie Spiker, 2017). This could be done by set of cost-effective activities such as food recovering waste prevention. In addition, by monitoring loss and wastes at retail and consumer level to avoid; Spoilage, food discarded due to poor quality standards, expiration and consumer plate leftover. Lastly, the sectors can save foods that will be redirected to needy people as a means of corporate social responsibilities instead of default diffusion of food, thus improve their corporate image. Moreover, by optimizing purchase order and monitoring the service can result in saving the financial resource.

The focus of this project was to examine food waste drivers, quantify the amount in terms gap between current energy intake and recommended intake, and indicate current portion size. This information will be used to offer insight to the best practice and police approach for better management of food wastage from the point of purchase to consumption. Furthermore, the research will highlight the losses occurring along the entire retail food chain, and makes assessment of their magnitude. Additionally, it will identify factors associated with food wastage and possible ways of control to enable efficient use and distribution of food produced which may (in the future) helps us monitor if such measures will have a positive impact on the magnitude of food insecurity in the urban population. In a world with limited natural resources, reducing food losses should be priority.

## **1.2 STATEMENT OF THE PROBLEM**

In low-income countries like Ethiopia food wastes have various economic problems, hence the idea of Food loss and waste should be put on the agenda of food security and economic

development program. Abandoned food wastage leads to negative economic, social, environmental and moral challenges in a given situation (Marthinsen and Sund, 2012). Since food loss and waste means nutrient loss, approximately, 4,600 kcal/day of food is harvested for every person on the planet; of these, only around 2,000 kcal, on average are eaten (Cooper, 2018). If so, where is the remaining 2600kcal/day then? Either it is lost or wasted or both. The amount can be more than enough for another person to feed if there is effortless attempts to save food loss and wastes. Food can be redistributed to food banks, food rescue agencies and other charities, which can direct it to needy, rather than discarded it. According to world food program, 11.8 million vulnerable people face acute food insecurity in 2020 (WFP, 2020). For several firms, food donation or redistribution is main part of their corporate social responsibility activities.

Beside, price of food have significant impact on purchase and therefore, overall quality of diet. Research data shows a high-quality diet was more expensive than a low-quality diet (Pedroni, 2021). Thus, due to financial constraint, there will be inconsistency of food access that can be associated with poor dietary intake. The extent to which campus food resources contribute to this association is unknown. Despite the poor dietary intake, it has been found that surplus edible food wastes in various campus in the country. Responsible consumption and production by minimizing wastage in all points of the supply chain will help the catering service provider to insist any price of food inflation.

### **1.3 SCOPE**

The scope of this research is to explore macronutrient loss within Food loss and waste in the service/retail businesses and portion size of the students who are enrolled in Addis Ababa Science and Technology

University. Waste and loss in the agricultural stages of production, food service (schools, hotels) supply chains, manufacturer and household food waste will not be covered.

### **1.4 SIGNIFICANCE OF THE STUDY**

The findings of the study will be helpful to encourage AASTU food service provider to improve their shopping, food preparation, food storage, and portion sizes can incorporate strategies to reduce waste/loss.

Serve as helpful guide for AASTU to plan purchasing and catering for large number of student or consumers based on accepted portion size. Provide information to government and voluntary

institutions like the one NGOs about nutrient lose along with food wastes. Provide information government and other stake holders for the development of programs and policies related to nutrient loses that are associated with food wastes. Mainly, It contribute significant role for UN sustainable development goals (SDGs) 1, 2 & 12 by providing quantified information about observed responsible consumption and production. Offer practical tools, information and activities designed to help facilities, organizations and governments prevent macronutrient loss that associate with food loss and waste (FLW), and recover and recycle food products saved for redistribution to ameliorate the state of food insecurity.

## **1.5 OBJECTIVES**

### **1.5.1 General Objective**

To assess the magnitude of macronutrient loss that has potential to narrow the gap in food energy inadequate intake along with Food loss and waste (FLW) at the consumer level and to suggest required amount based on supposed portion size.

### **1.5.2 Specific Objectives**

- Exploring the prevalence of food wastage in AASTU student café’.
- Quantifying the amount of macronutrient loss associated with food waste and estimating its Kcal/person/day contribution across AASTU food supply chain.
- To estimate and calculate average supposed portion size and recommend estimate average requirements based on observed current portion size
- Contextualize the amount of nutrient loss in terms of gaps between current and recommended intakes

## **2. LITERATURE REVIEW**

### **2.1 FOOD WASTE**

Several studies reflect various definitions of food wastes. Few researches tried to define food waste by aligning it with food loss. Food loss, food waste, bio-waste and kitchen waste, such terms have been used interchangeably for food waste definition. However, the sector scholars do not globally agree definition of food waste. This discrepancy makes the quantification of food waste difficult (Thyberg and Tonjes, 2015).

Different study reports provide comprehensive definitions for both Food loss and waste. Here in this paper the focus set on food waste rather than food loss. According to FAO study report, food waste is defined as: "...food appropriate for human consumption that is discarded (generally at retail and consumption stages) (FAO, 2017), or "...all food products allocated for human consumption that are instead discarded, lost, degraded, or consumed by pests at any stage of the food chain" (FAO, 2015).

Food loss defined as 'decrease in edible food mass throughout the part of the supply chain that specifically leads to inedible food for human consumption (Thyberg and Tonjes, 2015). Example could be, edible crops left in the field, food that spoils due to poor transportation infrastructure from factory to supermarket, food that contaminated during food processing etc.

Food waste: Food, which originally produced for human consumption but then discarded or not consumed by humans. Includes food that spoiled prior to disposal and food that was still edible when thrown away. Ex, plate waste, food that spoils due to poor storage in home or restaurant, restaurant food prepared but discarded due to lack of demand (Thyberg and Tonjes, 2015).

Food loss happens in early and middle part of the food supply chain. It includes loss on the farm, in manufacturing and production time. During farming food can be loss due to bad weather, pest damage and while transporting to the market. Similarly, food loss in the manufacturing site can be happens due to contamination of materials, low quality and expired ingredients. During production, food can be loss because of poor manufacturing facilities, damage and ineffective packaging (cooper, 2018). On the other hand, food waste happens at retails and consumer level. In the retail food can be waste due to damage in transit, poor planning (over stocking) and unsold stock. At home level, food can be wasted because of inappropriate purchasing, cooking too much, keeping till expired and through away leftovers (Thyberg and Tonjes, 2015).

## 2.2 FOOD WASTE QUANTIFICATION

Studies indicate that for the development of effective well-planned food waste prevention and management, food waste quantification is essential (Marthinsen and Sund, 2012). Reflecting the magnitude of food waste may be used as a stimulant for people to change their behavior towards food wastage. However, both different definitions and, the absence of acceptable quantification methods have been cited as reason for the significant data gaps regarding food waste quantities (Spiker, 2017). Several different methodologies have been used to quantify food waste, such as waste characterization sorts and materials flow modeling, attempt to quantify the amount of food waste disposed in municipal solid waste (wastes from residential, institutional, and commercial sector), food diaries, qualitative surveys/interviews, and food supply and nutrition data analyses (Herszenhorn, and Quedsted, 2014) , (Tostivint, 2016).

Existing data: when applying this method, some waste data may quantify edible waste, whilst other data may also include associated inedible parts. Similarly, the production data may include the total weight of product (including inedible parts) or may refer only to the edible material. Therefore, the calculations performed should be appropriate for the type of data obtained. A new estimation based on existing raw data: where there are records, which can be exploited to derive food waste data. New data based on new measurement: where there are neither significant ongoing project/initiative nor proper records. Data used in the estimation method can be collected by different means. These include use of questionnaires, Interviews, surveys, direct measurements, and mass balance. Questionnaires and interviews are methods for collecting data that are measured or estimated but not recorded. The information can also be recorded, but not publicly available. Interviews are more labor-intensive than questionnaires, but gives more insight because there is a chance for follow-up questions and for helping respondents understand questions (Tostivint, 2016).

Direct measurement refers to weighing or volumetric assessment of materials. This method will be done if no measurement data is available and mass balance is difficult to use. It has the disadvantage of being resource-intensive but it will enable the collection of very precise data (Lipinski and Austin, 2019) & ( Tostivint, 2016).

Mass balance is an indirect method of calculating food waste using data on e.g. sold harvest, total harvest, waste treatment, etc. Such calculations can be performed by calculating the

difference between the mass inflows and outflows (Lipinski and Austin, 2019) and (World Resource Institute, 2016).

The researcher focused to quantify food wastes at AASTU student café'. In this sector, few studies recommended that underlining an important distinction between pre-consumer and post-consumer waste are crucial. Pre-consumer waste is any waste that occurs before the food is on the customer's plate and post-consumer waste is any waste that occurs after that point (Brian Lipinski and Austin, 2019).

## **2.2 MACRONUTRIENT LOSS**

Based on Food and Agriculture organization (FAO) food can be defined as a substance that can provide nutrient while eaten (FAO, 2017). Nutrient also can be elaborate as substances, which promote body function, provide energy, support growth, maintain and repair body tissues (Global Panel on Agriculture and Food Systems for Nutrition, 2018). There are six classes of nutrients-that are carbohydrate, protein, fat, vitamins, minerals and water. Of which the first three group of nutrient namely carbohydrate, fat and protein further categorized under macronutrient. The remaining nutrients vitamin and minerals (including water) known as micronutrients (Kumar, 2019). There are other elements foods that do not contribute to the nutritional function or contribution of foods such as antinutrients, contaminates (chemicals, dirt and microorganism), additives or preservatives and harmless microorganism.

All living organisms consume food, mainly for the nutritional gain that can be obtained to sustain life and health. However, food and the consumption of food have a significant role in the social, psychological and religious human activities/attributes of human life.

Does food waste associate with nutrient lose? Based on the definition of the term "food" we can automatically answer this question, food wastes are directly related to the loss/waste' of both macro and micronutrients. In this research due focus given to macronutrient loss along Addis Ababa Science and Technology University (AASTU) café. Majority of the Ethiopian diet contain animal foods such as meat, milk, egg, plant like cereal and pulses and vegetable, fruits. All these food groups contain macronutrient in different proportions (Tekile, 2019).

Local food composition table, can be used to calculate losses of nutrients, e.g. for every 100g of bread wastage there will be on average 6.8 g of protein, 45.7g carb and 0.8 g of fat loss. In US food supply chain, there was total of 1216.5 kcal energy lost with 146.4 g of carbohydrate, 32.8g protein and 57.2g total fat daily per capita nutrient loss from 213 commodities at the retail and consumer levels in 2012 (Marie Spiker, 2017). What is the figure looks like in our

country Ethiopia? Not yet done. However this research will provide scientific data for macronutrient loss in a given study area and will help as initiators for future studies.

Comparing the daily loss of these nutrients with the suggested adult (average male) macronutrient requirement, of carbohydrate 370 g/d, fat 65 g/d and protein, 70 g/d (Kumar, 2019), near half – (146.4g) of carbohydrate, half of protein (32.8g) and 57.2 g total fat loss of the daily recommended macronutrient intake. The amount of daily macronutrient loss is a significant figure of loss that signal prevention of wastage alarm.

### **2.3 PREVALNCE OF MACRONUTRIENT DEFFICENCY**

The major food energy deficiency issues affecting region in Ethiopia addressed in the WFP report are shown in Table-1. The most common forms of macronutrient deficiency are protein energy inadequate intake. The majority of them are in Amhara region. It is assessed that over 2 children are stunt, under 26.7% households have inadequate macronutrient intake and 14.6 % million preschool-aged children are protein energy deficient (WFP, 2018). From a public health perspective, macronutrients are a concern because food energy inadequate intake, being a risk factor for many diseases, can contribute to high rates of morbidity and even mortality. It has been estimated that protein energy deficiencies account for about 14.6 % in Addis Ababa burden of disease, with acute malnutrition ranking among the leading causes of the city disease burden (Woya, 2019). The groups most vulnerable to macronutrient deficiencies are low income households and children, mostly because they have a relatively greater food poverty rate that nexus with inadequate food energy intake (WFP, 2018). Macronutrient deficiencies increase the risk of dying due to infectious disease and contribute to impaired physical and mental development – Stunting (Tulchinsky, 2010). Individual medical or diet treatment cannot permanently deal with macronutrient deficiencies of such widespread proportions. Some are developed in recent dietary patterns and few result from life situations determined by place of residence, religious practices, and recreational activities, household income (poverty) (Thyberg, 2016).

Region	<sup>a</sup> Total Food production in millions of quintals (2015)	Inadequate food energy consumption (%) households	% of food energy deficient households (< 2550Kcal per adult equivalent per day) urban area-2016	% Food poverty/ 2016	Stunting
Addis Ababa	-	26.7	27	19.1	14.6
Tigray	4.4	38.4	27	32.9	39.3
Amhara	21.7	54.7	24	31.3	46.3
Oromia	42.6	23.3	20	20.5	36.5
Somali	0.7	15.5	18	25.5	27.4
SNNPR	28.4	13.9	23	24.5	38.6
Gambelia	0.2	11.8	9	17.2	23.5
Harari	0.1	36.7	50	6.3	32
Dire Dawa	0.1	8.2	5	12.2	40.3

Table 1 Food Energy deficiency condition and their regional prevalence

Source: WFP and Central Statistical Agency, 2016. <sup>a</sup> (Baye, 2019)

In the table-1 food energy malnutrition- stunting manifested in the urban area with the count of 14.6 and 39.3% for Addis Ababa and Tigray and 32% in Harari. However, there is undeniable food wastage in their respected campus that can be used for human consumption by reducing loss and redirecting the meal to the needy people. Beside, food lost and waste mean loss in water, resource, energy, fertilizers, pesticides, man-hours, fuel, transport costs, processing & packaging, manufacturing & commercial energy (Thyberg and Tonjes, 2015).

Ensuring the food security of an estimated 9.7 billion people by 2050 in an equitable and sustainable way is identified as one of the most crucial challenges facing society today (UN , 2015). These two situations has to align in the way that enable the world to resolve hunger issues. Hence, the huge gap should study careful and comprehensive to help with balancing food supply and demand.

In Ethiopia 13.9% urban households are food insecure (WFP, 2020 & CSA, 2019). Increasing food production and supply will not necessarily end this problem if unnecessary and avoidable wastages are not controlled. Distribution of food, and actual consumption should also be examined to find out factors that predispose to avoidable wastage. In this research paper, the project has tried to explore factors related to food wastes at the AASTU food supply chain in

Addis Ababa. Moreover, along with food wastage, macro nutrient loss can also happen at any spot of the supply chain. The lost can be due to inaccurate planning, cooking too much, food kept until expired, throwing away leftovers and soon (Kennard, 2020).

## 2.4 MACRONUTRIENT REQUIREMENT

Recommendations for macronutrients intakes differ from one country to another and also have dissimilar value for various age groups and sex. There is a slight difference on recommendations of macronutrients intakes among countries, a joint World Health Organization (WHO) and Food and Agricultural Organization (FAO) have edited recommendation (Table 2). Based on FAO/WHO, the Recommended Dietary Intake (RNI) for carbohydrate set to 260 g/d for all adults (Borg, Macronutrient Intake and Inadequacies of Community-Dwelling Older Adults, 2015). The recommendation for protein is 46 for adult female and 56 g/d for adult male

Macronutrients	<sup>a</sup> Mean energy and nutrient production per capita/d	Recommended Dietary Intake (RDA age 19-30 y)	NRV	Mean current in A.A,2020 (Age >30 yr.)	CV	Safe level
<b>Adult Female</b>						
Energy(Kcal)	3503	2000	2000 <sup>b</sup> RDA	1490		
Carbohydrates (g)		260	<sup>c</sup> 55-75 AMDR	193.7		
Protein (g)	84.7	46	66 RDA	30.5	12%	83
Total fat (g)	-	<70	<sup>c</sup> 20-35 AMDR	52		
Dietary Fiber (g)	-	25		18.6		
<b>Adult Man</b>						
Energy(Kcal)	-	2000	2450 <sup>b</sup>	1788		
Carbohydrates (g)	-	260	<sup>c</sup> 55-75 En%	193.7		
Protein (g)	-	56	66	41.7	12%	83
Total fat (g)	-	<70	<sup>d</sup> 20-35 En%	52		
Dietary Fiber (g)	<sup>a</sup> -	38		28.3		

<sup>a</sup> FAO/WHO,2008, <sup>b</sup> WHO/FAO,2001, <sup>c</sup> WHO/FAO,2007, <sup>d</sup> WHO/FAO,2010

## **2.5 PREVENTION AND CONTROL OF MACRONUTRIENT LOSS**

### **2.5.1 Main drivers of macronutrient loss**

Study reports showed that food wastes from worldwide hospitality restaurant's operations accounts for 30% of the whole food wastes which is correspondent to 0.4 billion tones every year (Were, 26th). For this amount, food wastage different factors have been identified.

Research indicates both canteen management team and consumer's behavioral choices have significant impact on food wastage at the retail level. Food may be waste within journey from planning, shopping, storage, preparation up to consumption at most (Thyberg and Tonjes, 2015).

Forty-five percent of waste and losses is registered because of food preparation and cooking processes within the kitchen, 21% because of poor food storage and 34% by customers as plate leftover (Were, 26th). Poor planning at the shopping stage end up in over-provisioning or bulk purchases, which are significant contributors to food waste. Unplanned purchase will lead in to bulk storage, which has its own impact on waste as well. Specially, packed food items, which go out of date in the storage, contribute a lot. Food wastage due to improper or unsafe storage, poor visibility in refrigerators, and partially used ingredients also, results in wastage.

In the canteen, wastes may be generated due to both preparing too much or inadequate food. Cooks or canteen employees may lack the skills to prepare food well, or to reuse leftovers. A portion of meal court, food waste was due to the preparation and serving of more food than could be consumed (Papargyropoulou, 2019). Researchers conducted in retails showed that, there 15.7% preparation waste, 6.6 costumer plate leftover, and 6.2% buffet leftover waste (Papargyropoulou, 2019). Inexperienced chefs probably may find it difficult to estimate how much to cook, on the other hand, too much food might be prepared. Portion sizes in Ethiopian food serving areas or retails restaurant is not defined in the way that can prevent wastage. However, international standard hotels portion size may be measured in the sizes of consumer's plates, and serving sizes as presented in cookbooks (Marthinsen and Sund, 2012). Seasonality also has potential impact for the generation of food waste. In Ethiopia, situation food can be spoil or wasted during summer season due to warm temperature. Seasonal variation also affects the number of customers served, which may contribute to the fluctuation of food waste

during the hospitalities ‘busy’ and ‘quiet’. In addition, other factors such, food-serving operation, due to choices, regarding quantities of available food and visual qualities of food etc. can be accountable for the wastage in the sector (Thyberg and Tonjes, 2015).

### **2.5.2 Food wastage Control Stage**

Researchers have proposed the use of food recovery hierarchy, which proposes three levels of Food loss and waste control. Prevention, recovery and recycling. However, prevention focuses on food wastage at the source and thus offers significant ways out that prevent waste in restaurants, and with greatest economic value and net environmental benefits.

### **2.5.3 Portion size as means of food waste prevention**

Offering diverse portion sizes, changing food types and monitoring food waste are all ways that can help cut food waste in the catering sector. Predefined demand size will contribute significant role to monitor food supply based on good meal planning strategies. All foods served during each day period has to be provided either based on baseline data or estimated portions, depending on the experimental condition. Study show that, for food items at common meals, the portions served to women were 25% smaller than the portions served to men (Rolls, Roe, and Meengs, 2007). The meals served in the baseline condition has to provide a mean of 2100 kcal/d for women and 2400 kcal/d for men (Matthys, 2003). The total amount of energy served in the catering service (2200 kcal/d for women and 3000 kcal/d for men) has to be labeled as excess of energy supplies of the total energy served.

## **2.6 THE IMPORTANCE OF FOOD WASTE PREVENTION**

Detailed facts and data generated on wasted food have significant role in the sector improve food security and to prevent loss along the food value chain (Rezaei, 2017). Food wastes and loss prevention has also many advantages. Among the advantages researches tried to look it from different angels, economical, food insecurity and environmental influences perspectives.

### **2.6.1 Economical Perspective**

As incomes increases, food expenditures will also increase because foods are not considered as such as portions of their income, (food expenditure is a very small proportion of their total expenditure) (Thyberg, 2016). In U.S., when food is compared with other expenses (such as housing) it is relatively inexpensive (Marie L. Spiker, 2017). The FAO suggest that the careless attitude of consumers who can afford to waste food is a large contributor to household

food wastage (Thyberg and Tonjes, 2015). USDA studies showed that, poorer countries, expenditures on food are high. For example, in Pakistan 47.7% of disposable income was spent on food in 2012; in Cameroon, it was 45.9%, In Ethiopia 48.9% (Puri, 2016). Estimated amount of annual food loss and waste worldwide is estimated at US\$ 1 trillion (Global Initiative of food lose and waste reduction, 2015). Africa shows commitment to end hunger by 2025 (Global Initiative of food lose and waste reduction, 2015), However there is food loss and waste which is uncontrolled, for example in Sub-Saharan Africa, 17% food were wasted during harvest and 18% post-harvest, 6% on distribution, 12.5 % on consumption (Puri, 2016).

### **2.6.2 Food and Nutrition Insecurity Perspective**

There is direct relationship between food and Nutrition insecurity. Food security can be define as the availability and the access of food to all people, whereas nutrition security linked with the intake of wide variety of food, which can provides essential nutrients (FAO, 1996). Thus, study will use these two terminology alternatively. According the 1996 World food summit report, food security was defined as; “Food security, achieved at all levels which is at the individual, household, national, regional and global levels, when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life’ (FAO, 1996).

New research report indicates that there are 27 million food insecure people live in East Africa. Of which the worst affected nation in 2018, in terms of acute food insecurity was Ethiopia. Around 8.1 million people had food insecurity in the same year (WFP and Central Statistical Agency, 2019). The country has remained one of the most susceptible countries for any kind of shocks related to draught and food insecurity. On top of this, there are enormous amount of food wastage in any spot of food supply chain. This unquantified and unknown amount of food wastage and loss in the food supply chain contribute significant role for food insecurity (UN, 2015).

### **2.6.3 Environmental Impacts of food waste disposal**

Food loss and waste are related to wastage of water, land, energy and other natural resources used to produce food. In fact, research showed that 4.4 Giga-ton of greenhouse gas emission of Carbon dioxide in to the atmosphere are estimated annually (Rezaei, 2017). Given that climate change has become a major concern, dealing with climate change mitigation measures is

mandatory. Several scholars agreed that the most effective way is by reducing food loss and waste in their operations (Herszenhorn and Quedstedt, 2014), (WRAP, 2013).

It is obvious that, food production and distribution require large amounts of energy and resources. During the process main environmental resources as water, soil, and air are exposed to food production operations. This can contribute to water pollution and soil degeneration, particularly due to the leakage of chemical and contaminants, such as manure and fertilizers, into the broader environment. In addition, agricultural process of food may lead to soil sediment transport and deposition in the downstream, as well degradation of water bearing ground zone (Aquifers) (Thyberg and Tonjes, 2015). Poor operation in the food supply chains can also lead to air pollution, including greenhouse gas emissions from agricultural machines and food transport vehicles (FAO, 2015). Direct effects of food supply systems on the land include soil erosion, nutrient depletion, on and off site pollution, deforestation, desertification, and biodiversity loss (FAO, 2017).

### 3. METHODOLOGY

#### 3.1 STUDY DESIGN

A cross sectional study conducted in purposively selected food courts/cafeteria in Addis Ababa Science and Technology University (AASTU), Ethiopia. The university was selected based on access, availability, type of food service (such as buffet style), and size (number of meals served per day).

Studied Food Items	Specific criteria	Av. No. of meal served per day	Type of service	Type of FLW
Injera	Red and white mix teff	600	Breakfast, lunch, dinner	Consumer leftover
Bread	White wheat	240	Lunch	Consumer leftover
Pea	Atere Kike	243.3 ml	Lunch and dinner	Consumer leftover
Lentils	Messer Kike	122.7ml	Dinner	Consumer leftover
Vegetables	Cabbage	153.4gm	Lunch	Consumer leftover

Table 3 Study food items and available serve size per day

Qualitative and quantitative data collection methods were used in this study to identify processes and activities within the operations that lead to food waste and to measure the amount of food waste generated from each spot in the kitchen of food service operators. The quantitative methods measured the amount of food waste generated, whereas the qualitative methods built a better understanding of the causes, patterns and type of macronutrient losses and food waste generation.

#### 3.2 STUDY AREA

The scope of current food waste inventory year (2020/2021) for serving area in the AASTU student café' using the FLW standards. Food waste in this inventory only goes to plate leftover.

### 3.3 STUDY POPULATION

Study subjects are male and female students enrolled at Addis Ababa Science and Technology University, Addis Ababa, Ethiopia. The café’ serves foods three times per day for 3500 students. Hence, the base population for portion size and FLW inventory was 3500 serves per capital.

### 3.5 SAMPLING TECHNIQUES

Random sampling method was used to select portion size and collected plates with leftover. Moreover, random sampling technique was used to select male and female student consumers for socio-demographic data. Furthermore, the student was served the food items separately in their plate compartment.

#### 3.5.1 Sample size determination

The sample size was determined by using a single proportional formula assuming the prevalence rate of food wastage in food service providers’ is found to be 50%± 5% ( p-value for unknown prevalence) (Eric, 2020), 95% confidence level, and design effect of 1.0. Based on the number of 3500 plate meal served per day sample size will be 347 plates per serve per day using the following formula:

Table 4 Sample size determination

<b>Sample Size in a Population</b>	
Population size(for finite population correction factor or fpc)(N):	3500
Hypothesized % frequency of outcome factor in the population (p):	50% +/-5
Confidence limits as % of 100(absolute +/- %)(d):	5%
Design effect (for cluster surveys-DEFF):	1
<b>Sample Size(n) for Confidence Levels</b>	
Confidence level (%)	95%
Sample Size	<b>347</b>

Sample size  $n = [DEFF * N * p(1-p)] / [(d^2 / Z^2_{1-\alpha/2} * (N-1) + p(1-p)]$  Results from OpenEpi, Version 3, open source calculator—SSPropo

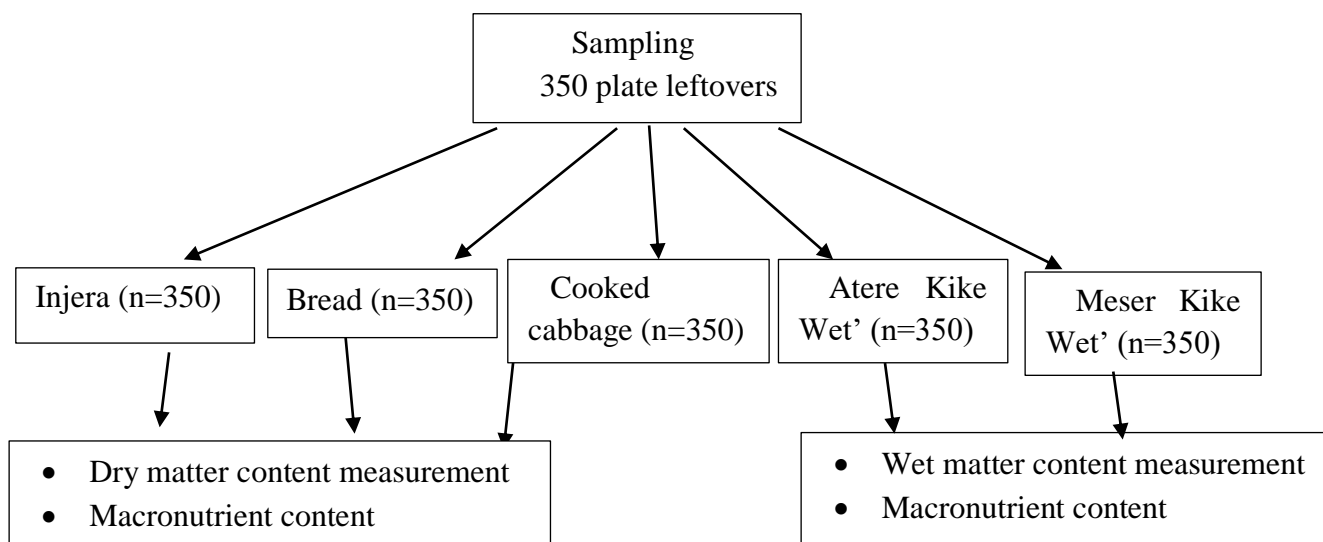


Figure 1 Schematic representation of the overall study design

- Injera served 3 times (breakfast, lunch and Dinner), daily loss measured plate leftovers will be merge for the total leftover per day
- Cabbage and lentils served one time only, one plate waste can be taken as waste per day. Atere Wet' served 2 times per day, 2 plate leftover were merged for leftover per day.
- Average sample size for all food Items = 350 plates. Both gender had given equal chance of sampling. Therefore we measured 50% from female consumer and 50% from male consumer plate leftover.

### 3.5.2 Sampling Instruments

Instruments and equipment's necessary for the conduction of the survey were electronic balance BIOBASE model BA2204B Max 500gm and Min 0.1mg.

### 3.6 DATA COLLECTION METHODS

In the food waste inspection, the amount and type of food waste were measured and recorded continuously throughout the day and for a sufficient length of time. Data was three-days continuously using a pre-prepared format (Annex-1), in order to account for daily variation (World Resource Institute, 2016). During the study period, the consumer level (plate leftover) types of food waste was monitored. Plate waste refers to the volume or percentage of the served food that is discarded. By direct weighing the amount of each food component on each plate leftover quantitative data was collected to be analyzed for its nutrient content. Each food

Items were served separately for effective waste measurement. Injera, bread and cabbage were measured in dry mass (w/w) and messer and atere Kike Wet' measured in wet mass (w/w). Additional to find out the reason behind the wastage, data was collected by a face-to-face interviewing technique using semi structured questionnaire (Annex-2).

### **3.7 DATA ANALYSIS**

Quantitative data (amount of leftovers per capita) was checked for completeness and consistency. Then it was coded and entered in the computer using excel. Likewise, qualitative data (food waste drivers) was coded by assigning labels to various categories and entered to a computer. Then the data converted to SPSS version 20 for descriptive statistics and T-test was conducted to establish the relationships between female and male plate leftovers.

### **3.8 CALCULATION OF NUTRIENT LOSS EQUIVALENT (NLE)**

Common staples from each commodity was selected that have high waste rate in the café'. From cereal: Injera and bread vegetable: cabbage, Pules: Pea and lentils. Average representative sample food waste was matched from Ethiopian local food data base nutrient content for equivalent macro nutrient content. The amounts of macro nutrient loss along with the food waste were computed by matching with food composition table data series (part IV) of Ethiopian Health and Nutrition Research Institute (EHNRI, 1998). For each food items, corresponding nutrient content was obtained from EHNRI for a standardized 100g unit of food. A detail explanation of all calculation attached in the Table-5 and 6. Hence, the analysis was limited to the consumer level at the AASTU food supply, calculation were provoked to annual per capital waste at the retail levels for each food items, thereby excluding wastes from non-edible portion. Afterwards, the amount of each nutrient present in this amount of waste was calculated, and amounts were summed by nutrient to estimate nutrient loss per capital per day basis. To estimate losses per capital per year, the nutrient loss per capital per day was multiplied by number of serves per year. To estimated nutrient loss on a population per capital per day bases, nutrient loss per capital per day multiplied by the 2021 AASTU population of cafeteria user (which was 3500 consumer or plat).

Table 5 Calculation of macronutrient loss along with the food waste at consumer level in AASTU café

Calculation percent weight /volume (% W/V) to determine dry mass of Ater Wet' (pea) and Messer Kike Wet' (Lentils) Example: Atere Kike Wet' dry mass calculation

Recipe = 95Kg per 420 Kg Wet' = 0.226 Kg/ Kg= for serve time( lunch), where by definition percent w/v solution is the measure of 0.226 Kg/ Kg = 22.6 g of solute / 100 gm Wet' = 22.6% w/w we can calculate for pea/ Ater Wet' as well:

average serve size = 243.3 ml/capital (Tabel-3), here in the research, the study used data from EHNRI data serious and Actual laboratory result to calculated amount of nutrient content to compare the amount of wasted Ater along with solution (Wet').

Calculation for Nutrients Loss Equivalent (NLE)

Example: In the case of carbohydrate for one food ( in case of bread):

Step-1: How much gram of carbohydrate is contained in standard 100g of white bread. According to EHNRI food composition data serious (IV) for 100 g bread (made of white wheat) contain 36.1 g of carbohydrate

Step-2: How much bread is waste in the consumer level / plate leftover/ let the research survey provide the following information about bread wastes:

Year	serving size	consumer leftover/waste/ per day	carb continent per 100g of bread
2021	125g	55.5g	36.1

Step-3: Calculate equivalent carbohydrate loss along with the plate leftover/waste/:Equivalent carb loss = (62.5g \*36.1g)/100 g = 23.5 g carbohydrate will loss along with 62.5g bread waste per capital per day/capital per year bread waste can be calculated = Number of serves per day \* average estimated waste\* Number serve days per year

In case of bread: = 1\* 55.5\* 300= 16,560g= 16.56 Kg bread waste per year. Which is equivalent to 132 whole bread per capital per year. There are 3500 consumer at a time, which will give a total of 462,000 whole bread waste per year for that particular study area.

Carbohydrate loss per capital per year=( 16560g \*36.1)/100 = 5978 g per capital per year of carbohydrate will loss together with the waste.

### 3.10 COMPARISON OF NUTRIENT LOSS WITH DIETARY INTAKE

The contextualized macronutrient loss, gaps between recommended and current intake were calculated. Mean current nutrient intake were obtained from research survey and were compared with Average annual consumption of different food groups in Addis Ababa sampled in the 2016 HCES/ Household expenditure and consumption survey. Recommended intakes also presented, based on the Recommended Dietary Allowance (RDA) or the AI. For recommended intake,

“Adult” indicates for those consumers aged 17-30 years old. For energy, 2,000 kcal/ day was used as the recommended intake for both men and women, although actual needs depend on height, weight, and physical activity.

### 3.11 OBSERVED PORTION SIZE

Current observed portion size computed from collected data, which is equal to given amount of diet subtracted from each individual consumer plate leftover. This calculation is essential to estimate average meal requirements per day, which later used to maintain supply and demand equilibrium balance

Table 6 Portion size calculation to estimate the amount of macronutrient intake gm/capita/day

Example: In the case of carbohydrate for one food ( in case of bread):

Step-1: How much gram of carbohydrate is contained in standard 100g of white bread.

According to EHNRI food composition data serious (IV) for 100 g bread (made of white wheat) contain 36.1 g of carbohydrate

Step-2: How much bread is taken by the consumer let the research survey provide the following information about bread wastes:

Year	serving size	intake per day	carb content per 100g of bread
2021	120g	95 g	36.1

Intake per day is obtained by subtracting leftover from given amount.

Step-3: Calculate equivalent carbohydrate gain:

Equivalent carb intake =  $(95g * 36.1g) / 100 g = 34.3 g$  carbohydrate will intake along with 95g bread eaten per capital per day.

Per capital per year can be calculated = Number of serves per day \* average estimated intake\*

Number serve days per year

### **3.12 DATA MANAGEMENT AND ETHICAL CONSIDERATION**

Nutrient composition data referred from the Ethiopian Health and Nutrition Research Institute (EHNRI-1998) data serious and compiled into spreadsheets in Microsoft Excel for calculations. Nutrient composition data for each food were stored in a separate file coded in a single Excel spreadsheet. For all data that transferred from one file to another, sub-sample double-checked and discrepancies were resolved by referring to the original data sets. The final refined data coded to SPSS version 20 for descriptive statistics. Since recipe is specific in the different area nutrition content conducted in the food laboratory for Wet' loss but for other food items data derived from local food composition table (Annex-4). Below table-6, describe data management step by steps. Ethical clearance obtained from Addis Ababa University collage of Natural and Computational Science, review board.

Table 7 Data sources and calculation used to generate estimates of nutrients loss in the AASTU cafe'

Data Source	Process
Nutrient Composition	<p><b>Obtained Nutrient composition data</b></p> <p>For each of the food selected, obtained amount of calories, macronutrient and fiber per 100 g.</p>
Food Waste	<p><b>Direct measure the amount of food waste from consumer level/ plate leftover.</b></p> <p>For each of food items, separate the amount of food loss at the consumer level per capita per day.</p>
Macronutrient loss	<p><b>Calculated nutrient loss:</b></p> <p>For each of food groups:</p> <ol style="list-style-type: none"> <li>i. Calculate the amount of each nutrient present in the weight of consumer level food leftover per capital per day</li> <li>ii. Sum the amounts by nutrient to estimate the amount of nutrient loss per capital per day and scale up the population to get loss in the AASTU food supply</li> <li>iii. Multiply the sum by the number of days served per year to find out the loss per capita per year</li> </ol>
RDA for Adult (17-30 age)	<p><b>Contextualized nutrient loss relative to:-</b></p> <ul style="list-style-type: none"> <li>- Recommended intake</li> <li>- Gap analysis between current mean intake and losses</li> <li>- The amount of loss that could be cost effectively recovered</li> <li>- Economical loss</li> </ul>
Mean Current intake from AASTU café' daily serve	
Current price for each food items-obtained from AAST U café administration	

### 3.13 CONCEPTUAL FRAME WORK

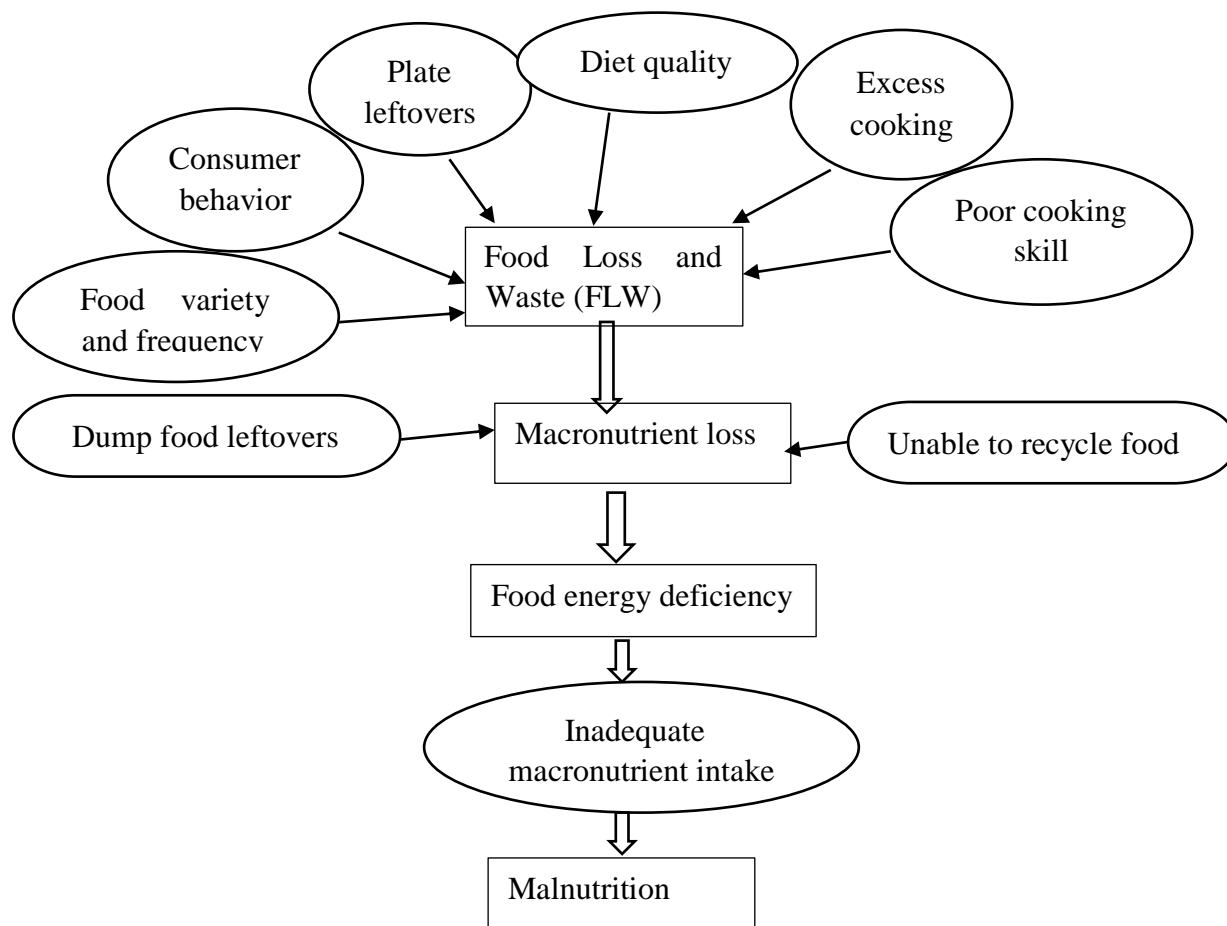


Figure 2 Conceptual framework for the study of macronutrient loss and food waste

### 3.14 DISSEMINATION OF THE RESULTS

The findings of the study were submitted to both Addis Ababa university center of food science and nutrition and AASTU. The results will be communicate through publication on local or international journals.

## 4. RESULTS

### 4.1 CONSUMER SOCIO DEMOGRAPHIC CHARACTER

The questionnaire included general indicators of driver and cause for food waste, frequency and reason of leftover. Three hundred and twenty students who are both AASTU students and cafeteria users participated with response rate of 92%. Descriptive statistics applied for the data. Among the respondent females constituted 50% (160). All were between the ages of 17-22yr. The questionnaire also included pre-assessment data to investigate the reason behind the leftover in the university café.

Table 8 Socio-demographic characteristics of AASTU cafe consumer

Variables		Frequency	Percent
Gender	Male	160	50
	Female	160	50
Age	17-22	320	100
Medical history	Gastro intestinal disorder	79	4.7
	No at all	241	95.3
	Total	320	100
Medication that restrict food intake	Have no medication	320	100
Any dietary supplement that inhabit food intake	Have no supplements	320	100
Food allergies that restrict food intake	Have allergies	1	0.3
	Have no allergies	319	99.7
Any stress	Increase food intake	50	13.3
	Suppress food intake	267	86.7
Do you smoke	No	320	100
Do you drink alcohol	No	320	100
Do your emotion affect the way you eat	Yes	41	11.7
	No	275	88.3
Did you fasting or starve yourself	Yes	25	7.1
	No	291	92.9

Do you enjoy food	Yes	319	99.7
	No	1	0.3
The food is served hot and fresh	Strongly disagree	7	2.2
	Somehow disagree	3	.9
	Neutral	53	16.6 30.6
	Somehow agree	98	49.7
	Strongly agree	159	100.0
	Total	320	
The serve has good variety of items	Strongly disagree	24	7.5
	Somehow disagree	183	57.4
	Neutral	84	26.3
	Somehow agree	15	4.7
	Strongly agree	13	100.0
	Total	319	
The quality of cooking is excellent	Strongly disagree	53	16.6 60.2
	Somehow disagree	192	18.2
	Neutral	58	3.1
	Somehow agree	10	1.9
	Strongly agree	6	100.0
	Total	319	
The food is testy and flavorful	Strongly disagree	16	5.0
	Somehow disagree	106	33.1 50.9
	Neutral	163	10.6
	Somehow agree	34	100.0
	Total	320	
	Service hygiene and quality of food	Strongly disagree	7
Somehow disagree		2	.6
Neutral		76	23.8 63.4
Somehow agree		203	9.7
Strongly agree		31	100.0
Total		320	
Serving too much amount	Strongly disagree	19	5.9
	Somehow disagree	177	55.3
	Neutral	104	32.5
	Somehow agree	20	6.3
	Total	320	100.0
	Spoiled food is served	Strongly disagree	225
Somehow disagree		95	91.4
Total		320	

## 4.2 PREVALNCE OF FOOD WASTE

During the survey day on average of 107.0 kg protein, 517.0 Kg Carbohydrate, 271.0 Total Fat, 104 Kg dietary fiber and 13538 MJ energy lost embedded with 1811.2 Kg wasted food per day in the form of plate leftover. The amount of waste was linked to the total number of consumers during the selected time (N=3500). Fasting meals composition was the highest plate leftover during the whole period under analysis. Rice and Meat serving days had the smallest amount of food waste recorded which was Tuesday, breakfast and dinner respectively, relatively very small amount of waste collected.

Table 9 Amount of Food served and wasted

Food Items	Weight during serve g/capita/serve	Mean Weight Leftover g/capita/serve
Injera	600.4	267.1
Bread	240.5	58.8
Atere Kike wet'	243.3	64.7
Messer Kike wet'	209.7	26.8
Cooked cabbage	152.9	61.4

Computed from AASTU meal recipe (Annex-3)

Table 10 Macronutrient content of selected common staples

Food	Mean Proteins (g/100gof food)	Mean Fat (g/100gof food)	Mean Carbohydrate (g/100g of food)	Mean dietary Fiber g/100g of food	Mean energy Kcal /100g of food
White and red Teff Injera ( sergegna Teff)	4.45	0.8	36.1	3.5	172.8
Bread( white wheat)	6.8	1.2	45.7	1.2	222
Pea/ Ater Kike Wet'/	21.6	7.2	61.7	2.8	353.8
Lentils/ Messer Kike Wet'/	23	1.1	61.4	2.4	355.1
Vegetables–Cooked cabbage	1.1	0.1	3.3	1.3	23.7

Source: Research Survey data (AAU Food laboratory result) which validated and confirmed with previously conducted Food composition table for use in Ethiopia part IV Ethiopian Health and Nutrition Research Institute (EHNRI), 1998

For carbohydrate in this table refers to the "total carbohydrate by difference", the difference between 100 percent and the sum of the percentage of moisture, protein fat and ash. The carbohydrate portion that is supposed to be utilized can be obtained by subtracting the crude fiber from the total carbohydrate.

Prepared foods included in this publication are heterogeneous in nature which were prepared by traditional practice as there is no standardized procedure. Thus, specific calorie factors are not used. Instead, the food energy factor which were based on the physiological energy factor usually called the Atwater's Factors, 4,9,4 to the percentage composition of protein, fat and carbohydrates (without crude fiber) were use (FAO, 1968). Results of carbohydrate and energy content are reported in Table-10 above which are similar with the result of EHNRI (1998) results.

Table 11 Nutrients compassion laboratory result

FAT					
SAMPLE CODE	Sample. wt in gram( dry mass)	Extract wt.	Extract + fat	% Fat	average
Atere kike Wet'	2	177.87	178.08	10.5	10.25
Atere Kike Wet'	2	195.98	196.18	10	1.1
Messer Kike wet'	2	191.76	192.86	1.1	
Messer Kike wet'	2	189.76	191.16	1.4	1.26
Mixed complete leftover meal	2	179.44	179.6	8	8
Mixed complete leftover meal	2	185.2	185.36	8	
PROTINE					
sample code	sample wt.	HCl consumed	total N2	% protein	AV
Atere kike Wet'	0.5	10.5	2.884	18.025	
Atere Kike Wet'	0.5	10.7	2.94	18.375	18.2
Messer Kike Wet'	0.5	10.7	3.12	23.27	
Messer Kike wet'	0.5	10.7	3.33	22.93	23.1
Mixed complete leftover meal	0.5	7.1	1.932	12.075	11.9875
Mixed complete leftover meal	0.5	7	1.904	11.9	

Moisture						
sample code	sample wt.	crucible wt.	cr + fresh sample	cr + dry sample	% moisture	AV
Atere kike Wet'	5.01	21.23	26.24	25.94	5.99	5.895
Atere Kike Wet'	5	21.23	26.24	25.95	5.8	
Messer Kike wet'	5	21.23	27.32	26.24	6.1	8.1
Messer Kike wet'	5	21.23	27.98		6.2	
Mixed complete leftover meal	5.01	21.16	26.16	25.69	9.38	9.28
Mixed complete leftover meal	5.01	21.92	26.93	26.47	9.18	
ASH						
sample code	sampel wt	crucible wt	crucibel wt+ash	% ash	AV	
Atere Kike Wet'	2.49	41.41	41.61	8.03	7.83	
Atere KikeWet'	2.49	45.38	45.57	7.63		
Messer Kike wet'	2.49	41.43	41.63	8.03	7.8	
Messer Kike wet'	2.49	44.73	44.82	7.6		
Mixed complete leftover meal	2.5	42.13	42.2	2.8	2.81	
Mixed complete leftover meal	2.49	39.49	39.56	2.811		
crude fiber						
sample code	wt of sampel	wt crucibel	wt cru&ash	wt of fiber	%crude fiber	average
Atere Kike Wet'	1	12.4454	12.4318	0.0136	1.36	1.365
Atere Kike Wet'	1	13.0125	12.9988	0.0137	1.37	
Messer Kike wet'	1	12.8917	12.851	0.0136	1.36	1.365
Messer Kike wet'	1	12.6301	41.6	0.0137	1.37	
Mixed complete leftover meal	1	12.8817	12.8495	0.0322	3.22	3.205
Mixed complete leftover meal	1	12.6357	12.6038	0.0319	3.19	
Computed result for carbohydrate and Energy content						
Atere Kike wet'	Carbohydrate g/100g		56.5			
Atere Kike wet'	Energy		345.6			
Messer Kike wet'	Carbohydrate g/100g		61.4			
Messer Kike wet'	Energy		355.1			

	Anaerobic plate count (APC)	NMT<100
Micro Biology result	E.coli and Coliform	Nil
	Yeast and Mold	Nil

wt. = weight, cr. =crucible

Table 12 AASTU cafe macronutrient serve size

	Energy Kcal/capita day	Carbohydrate g/capita/d	Protein g/capita/d	Total fat g/capita/d	Dietary fiber g/capita/d
Injera	1036.8	216.6	26.7	4.8	21.0
Bread	532.8	109.7	16.3	2.9	2.9
Atere Kike Wet'	861.9	150.3	52.6	17.5	6.8
Messer Kike Wet'	435.7	44.3	28.2	1.3	2.9
Cab	36.4	5.1	1.7	0.2	2.0
Total	2903.5	525.9	125.5	26.7	35.6

Source: computed from AASTU café' daily meal recipe and local food composition table (Annex-3)

The following prevalence of wasted amount was registered from 350 consumers' plate leftover during 2021.

- Injera Waste 31.7% w/w per serve
- Bread Waste 46.7% w/w per serve
- Atere Kike Wet' 26.9% w/w per serve volume;
- Messer Kike Wet' 21.8% w/w per serve volume
- Cooked Cabbage 40% w/w per serve

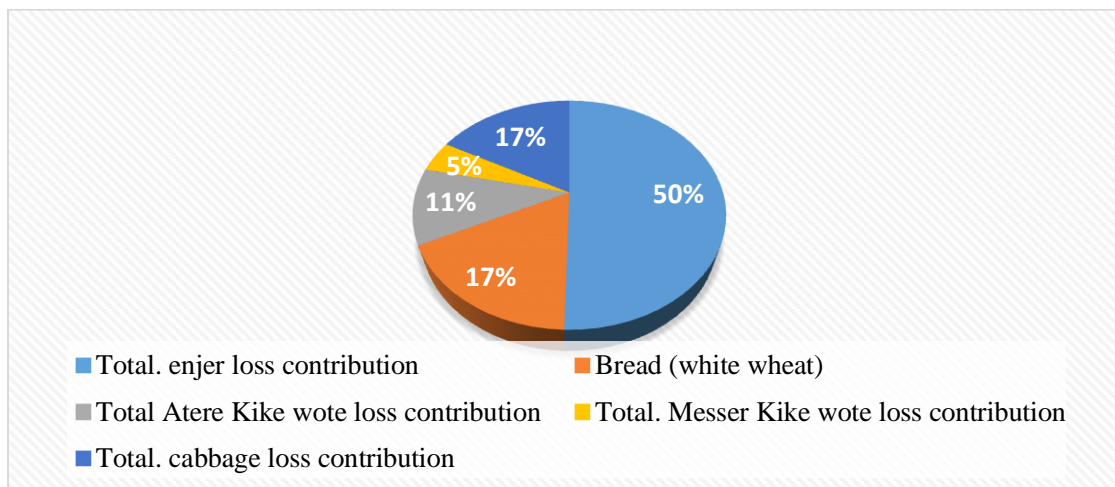


Figure 3 Percent contribution food items for the total food wastage

Table 13 Mean comparison for the total food waste of five common staples in AASTU cafe 2021

GENDER		Injera waste g/capita/d	Bread waste g/capita/d	Atere Kike Wet' waste g/capita/d	Messer Kike Wet' waste g/capita/d	Cooked cabbage waste g/capita/d
FEMALE	Mean	270.7	55.5	55.9	26	70.7
	Minimum	124.2	3.1	26.5	6.6	32.8
	Maximum	487.9	125	210.1	114.8	134.3
	Std. Deviation	68.1	27.6	24.6	14.2	25.3
	%CV	25.2	49.7	44.0	54.6	35.8
MALE	Mean	263.4	62.1	73.5	27.7	52.1
	Minimum	122.9	10.1	25.7	9.4	22.9
	Maximum	487.9	114.1	182.3	83.9	133.2
	Std. Deviation	56.8	31.7	30.4	19.6	21.9
	%CV	21.6	51.0	41.4	70.8	42.0
Total	Mean	267.1	58.6	64.7	26.8	61.4
	Minimum	122.9	3.1	25.7	6.6	22.9
	Maximum	487.9	114.1	210.1	114.8	134.3
	Std. Deviation	62.7	29.7	29	17.1	25.4
	%CV	23.5	50.7	44.8	63.8	41.4

For cabbage and Atere kike Wet' waste  $P < 0.01$  between the group and  $P > 0.05$  for the remaining food items

Scale up losses per population per day basis, nutrient loss per capita per day multiplied by the 2021 total consumer size per food items (3500) as specified by the AASTU cafeteria administration. As result, the average food loss given in the table below.

Table 14 Magnitude of plate leftover in AASTU cafe in 2021 that scale up to the population level

Food Items	Plate leftover Kg/day (weight mass (N=3500))	% share contribution for the total waste
Injera loss contribution	934.7	48% w/w
Bread (white wheat)	197.0	12% w/w
pea loss contribution (w/w)	226.5	12% w/W
Lentils loss contribution (w/v)	93.8	6% w/W
Cooked cabbage loss contribution (w/w)	359.2	23% w/w

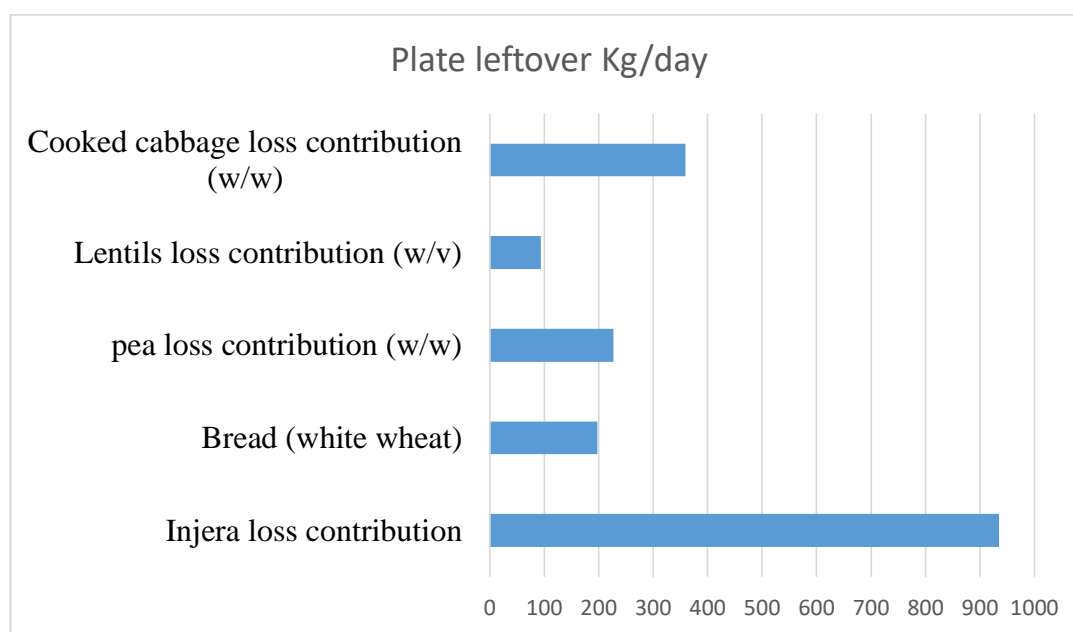


Figure 4 Comparison food waste in the total plate leftover in AASTU café

#### 4.3 MACRONUTRIENT LOSS ALONG WITH THE FOOD WASTE

Magnitude of macro nutrient loss of five commodities at the consumer levels of the AASTU food café' in 20201 are located in the table-15 below and macro nutrient loss are tabulated as per Table-10

Table 15 Mean comparison macronutrient equivalent loss associated with food waste in AASTU cafe' in2021

GENDER		Protein equivalent loss g/capita/d	Carbohydrate equivalent loss g/capita/d	Total fat equivalent loss g/capita/d	dietary fiber equivalent loss g/capita/d	Energy loss Kcal/capita/d
FEMALE (N=175)	Mean	30.89	175.8	7.7	48.3	897.9
	Std. Deviation	7.3	33.9	2	9.5	173.2
	%CV	23.6	19.3	26.0	19.7	19.3
	Sum	5405.9	30770.5	1346.6	8448.3	157123.7
	Mean	30.1	119.7	7.8	11.4	952.9
MALE (N=175)	Std. Deviation	8.3	28.3	2.3	2.1	188.94
	%CV	27.6	23.6	29.5	18.4	19.8
	Sum	5272.3	20942.3	1364	2005.3	166766
	Mean	30.5	147.8	7.7	29.9	925.4
	Std. Deviation	7.8	42	2.1	19.7	183.1
Total (N=350)	%CV	25.6	28.4	27.3	65.9	19.8
	Sum	10678.2	51712.8	2710.6	10453.6	323889.7

P>0.05 for fat equivalent loss and P<0.05 for carbohydrate, protein, dietary fiber and energy between the group. Accepted food waste in the catering industries extended up to 4-10% of the given portion size (Eriksson, 2017).

An independent sample t-test was conducted to compare the leftover with its equivalent macronutrient content for Female and Male respondents to compare the significant different in mean macro nutrient loss between the group.

Table 16 T-test analysis for crud food wastes

Independent Samples Test										
Food Items	Gender	Mean	SD	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Total plate leftover g/capita/d	Female	478.7	83	0.546	348	0.586	4.9223	9.0197	-12.8177	22.6623
	Male	473.8	85.7							
Injera waste g/capita/d	Female	270.7	68.1	1.078	348	0.282	7.226	6.7029	-5.9573	20.4093
	Male	263.4	56.8							
Bread waste g/capita/d	Female	55.5	27.6	-0.502	348	0.616	-1.5951	3.1769	-7.8435	4.6532
	Male	57.1	31.7							
Atere kike Wet' waste g/capita/day	Female	55.9	24.6	-5.964	334	0	-17.6246	2.9553	-23.4379	-11.8113
	Male	73.5	30.4							
Messer Kike Wet' waste g/capita/d	Female	26	14.2	-0.929	318	0.354	-1.6994	1.8299	-5.2996	1.9007
	Male	27.7	19.6							
Cooked Cabbage waste g/capita/d	Female	70.7	25.3	7.359	342	0	18.6123	2.5291	13.6376	23.587
	Male	52.1	21.9							

Table 17 T-test for macronutrients and energy loss

Independent Samples Test										
t-test for Equality of Means										
Nutrients and Energy	Gender	Mean	SD	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Protein Equivalent Loss g/capita/d	Female	30.89	6.43	0.912	348	0.043	0.7634	0.837	-0.8828	2.4096
	Male	30.01	7.73							
Carbohydrate Equivalent Loss g/capita/d	Female	175.8	37.52	16.838	348	0	56.1611	3.3353	49.6013	62.721
	Male	119.7	34.08							
Total Fat Equivalent Loss g/capita/d	Female	7.7	2.35	-0.432	348	0.666	-0.0994	0.2301	-0.552	0.3531
	Male	7.8	2.16							
Dietary Fiber Equivalent Loss g/capita/d	Female	48.3	2.97	49.973	348	0	36.8171	0.7367	35.3681	38.2662
	Male	11.4	3.18							
Energy Equivalent Loss g/capita/d	Female	897.9	203.3	-2.844	348	0.005	-55.0989	19.377	-93.2095	-16.9882
	Male	952.9	187.9							

#### 4.4 PORTION SIZE

The following intake observed in AASTU student cafeteria per day during the inventory year 2021. Recording was taken by deducting students 24hr left over from the total served weigh for each food items. The result is given table-18 below.

Table 18 Mean observed food intake (95% CI)

GENDER		Injera intake g/ capita/d	Bread Intake g/ capita/d	Atere kike Wet' Intake g/ capita/d	Messer Kike Wet' Intake g/ capita/d	Cooked Cabbage Intake g/ capita/d
FEMALE	Mean	358.3	88.5	138.6	141	82.5
	SD	86.8	38.2	33.1	14.6	25.2
	Minimum	63.6	2.1	24.8	52.2	16
	Maximum	569.7	188.6	197.8	179.4	120.5
	%CV	24.2	43.2	23.9	10.4	30.5
	Sum	62701.5	15483	24261.4	24676.6	14434.6
MALE	Mean	301.7	93.7	142	139.2	101.1
	SD	85.5	31.3	29.5	19.4	21.8
	Minimum	78.8	14.1	32	83	20
	Maximum	518.9	179.5	197.8	173.3	130.3
	CV	28.3	33.4	20.8	13.9	21.6
	Sum	52796.1	16400.7	24844.6	24361.8	17691.7
Total	Mean	330	91.1	140.3	140.1	91.8
	SD	90.6	34.9	31.3	17.2	25.3
	Minimum	63.6	2.1	24.8	52.2	16
	Maximum	569.7	188.6	197.8	179.4	130.3
	CV	27.5	38.3	22.3	12.3	27.6
	Sum	115498	31883.7	49106	49038.4	32126.3

P<0.01 for Injera intake and p>0.5 for the reset food items intake. Reference intake protein 46 and 56 g/d (RDA) for adult female and male respectively, carbohydrate 45-65 % En AMDR, for fat < 70 g/d RDA value for both adult female and male. Fiber 25 and 38 g/d for adult age female and male

Table 19 Equivalent macronutrients intake

GENDER		Protein intake g/ capita/d	Carbohydrate intake g/ capita/d	Total Fat intake g/capita/d	Dietary Fiber intake g/ capita/d	Energy intake Kcal/capita/d	Total observed Portion size g/capita/d
FEMALE	Mean	61.4	269.4	14.3	18.3	1740.8	775.6
	SD	6.4	37.5	2.3	3	203.4	99.9
	Minimum	38.1	138.6	6.8	9.4	1162	463
	Maximum	74.5	351.7	19.1	31	2297.3	1040.3
	%CV	10.4	13.9	16.1	16.4	11.7	12.9
	Sum	10736.7	47149.3	2505.1	3197.3	304646	135726
MALE	Mean	75.4	294.6	14.2	20.2	1655.2	720.1
	SD	7.7	34.1	2.2	3.2	187.9	89
	Minimum	54.1	194.3	6.8	9.4	1149.6	449.9
	Maximum	93.8	389	18.8	28.5	2249.7	1042.9
	%CV	10.2	11.6	15.5	15.8	11.4	12.4
	Sum	13196.1	51551.5	2481.2	3540.4	289659	126024
Total	Mean	68.4	282	14.2	19.3	1698	747.9
	SD	10	37.9	2.3	3.2	200.2	98.5
	Minimum	38.1	138.6	6.8	9.4	1149.6	449.9
	Maximum	93.8	389	19.1	31	2297.3	1042.9
	%CV	14.6	13.4	16.2	16.6	11.8	13.2
	Sum	23932.8	98700.8	4986.3	6737.7	594304	261750

P<0.01 for carbohydrate, protein and dietary fiber intake and p>0.05 for fat intake between the group

Selection of the predefined portion sizes based on available information, i.e. recipe assessments in AASTU. If different amounts had quantified a priori, diverse absolute intakes of food groups and nutrients would have been calculate. During the development of the questionnaire, however, predefining portion sizes following earlier definitions was the best possible procedure at that point,

although these portion size estimates were very old. Research evidence marked that usual portion sizes increased over time (Nielsen & Popkin 1977– 1998), which could have affected the comparison. Even though, this study suggests the use of recent reference data to specify fitted portion sizes in the AASTU cafeteria.

The association between food waste and portion marked that any desired alteration of consumer portion size will decrease food waste in general (Carroll, 2020). We used repeated 24Hr measurements for the validation study based on the assumption that the 24Hr dietary intake provide a reasonable quantitative assessment of dietary intake. The use of observed intake and waste record as recent reference data from a validation study to adjust fit portion sizes was useful to achieve macronutrient loss reduction data with an interpretable on an absolute scale. The ranking of study participants for nutrient or food group intakes could not be improve by fitting portion sizes. We consider our simple food frequency question with fitted portion sizes a cost-effective mechanism of reasonable rationality.

Similar study indicates that expected food waste in the catering industries extended up to 4-10% of the given portion size (Eriksson, 2017). Based on the above wastage standards, adjusted estimated portion size in table 16 is computed by adding 15% of wasted food amount on top of observed intake which will enable the university to save amount by 6-12 % Injera, 20-26 % bread, 11.9% Atere Kike, 6.8% Messer Kike and 1521% Vegetable (cabbage). In addition, the adjusted amount compare with recommended dietary reference based on 2000-calorie baseline for adults (17-22 years) male and female. Therefore, for carbohydrate 45-46% Kcal (130 gm for both female and male), 20-35%Kcal (46g for female and 56 for male), dietary fiber 14g/1000Kcal (30.6 for male and 28 for female). For example: For estimated portion size will be  $569+31.1=609.9$  gm per day that means 1.5 full Injera (1full Injera=340g) i.e., estimated portion size will be one full Injera plus quarter. Details are describe in table-21 below: Adjusted estimated portion size can computed either observed current intake plus SD or top-up fifteen percent of the loss amount on observed intake. After adjusting the predefined portion size with the estimated portion size given in the above equation individual gender based serve size management has to consider in order reducing food wastages. The significance difference are also further illustrated in table-20 which describe the difference in the mean intake of the given food items between female and male.

Table 20 T-test analysis for observed food intake

		Independent Samples Test								
		t-test for Equality of Means								
Food and macronutrient	Gender	Mean	SD	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Injera Intake g/capita/d	Female	358.3	86.8	6.15	348.00	0.00	56.60	9.21	38.49	74.72
	Male	301.7	85.5							
Bread Intake g/capita/d	Female	88.5	38.2	-1.41	348.00	0.16	-5.24	3.73	-	2.09
	Male	93.7	31.3							
Atere Intake g/capita/d	Female	138.6	33.1	-0.99	348.00	0.32	-3.33	3.35	-9.92	3.26
	Male	142.0	29.5							
Messer Intake g/capita/d	Female	141.0	14.6	0.98	348.00	0.33	1.80	1.84	-1.82	5.41
	Male	139.2	19.4							
Cooked Cabbage Intake g/capita/d	Female	82.5	25.2	-7.39	348.00	0.00	-18.61	2.52	-	-13.66
	Male	101.1	21.8							
Protein intake g/capita/d	Female	61.4	6.4	-	348.00	0.00	-14.05	0.76	-	-12.56
	Male	75.4	7.7							
Carbohydrate intake g/capita/d	Female	269.4	37.5	-6.57	348.00	0.00	-25.16	3.83	-	-17.62
	Male	294.6	34.1							
Total Fat intake g/capita/d	Female	14.3	2.3	0.57	348.00	0.57	0.14	0.24	-0.34	0.61
	Male	14.2	2.2							
Dietary Fiber intake g/capita/d	Female	18.3	3.0	-5.96	348.00	0.00	-1.96	0.33	-2.61	-1.31
	Male	20.2	3.2							
Energy intake Kcal/capita/d	Female	1740.8	203.4	4.09	348.00	0.00	85.64	20.93	44.47	126.81
	Male	1655.2	187.9							

For Injera and Bread intake equal variance is assumed ( $P > 0.05$ ). For Messer, Atere, Cabbage and Total observed portion size equal variance is not assumed ( $P < 0.05$ )

Table 21 Portion size analysis to estimate average requirements gm/capita/day in AASTU café

		<sup>a</sup> Injera gm per capital per day				<sup>b</sup> Bread gm per capital per day				Atere gm per capital per day				Messer Intake per gm per capital per day				Cooked Cabbage gm per capital per day			
GENDER		Observed intake (24HR)	predefined portion size	wasted amount	Estimated portion size	Observed intake (24HR)	predefined portion size	wasted amount	Estimated portion size	Observed intake (24HR)	predefined portion size	wasted amount	Estimated portion size	Observed intake (24HR)	predefined portion size	wasted amount	Estimated portion size	Observed intake (24HR)	predefined portion size	wasted amount	Estimated portion size
		M	358	840	271	358±68	89	240	55	89±28	139	244	56	139±25	141	210	26	141±28	83	153	71
FEMALE	Min	64		124		2		3		25		27		52		7		16		33	
(n=175)	Max	570		488		189		125		198		210		179		115		121		134	
MALE	M	302	840	263	302±57	94	240	62	94±32	142	244	74	142±30	140	210	28	140±20	101	153	23	101±22
(n=175)	Min	79		123		14		10		32		26		83		9		20		133	
	Max	519		488		180		114		198		182		173		84		130		61	
Total	Mean	330		267		91		3		140		26		140		7		92		23	
(n=350)	Min	64		123		2		114		25		210		52		115		16		134	
	Max	570		488		189		59		198		65		179		27		130		134	

M= Mean. Min= Minimum, Max= Maximum, SD= Standard deviation (wasted amount)

Estimated portion size = M± SD

## 5.0 DISCUSSION

The majority of the respondents (91%) had heard about the problem of food waste generation and management. Only few students indicated poor consumption of food served as contributing to their pre-define health problem. Around 0.3% of them linked the red 'Wet' ('Keye Wet') leftover for the cause of their allergies and near to 5% of student consumer associate their food leftover with their gastric problems. During stressful time, 86.7% of the consumer's appetite reported suppressed due to stress, and given as a reason for uneaten food and disposal. Almost all 99.7 % of the students in the survey reported they were healthy and can consume without hitch, and even 99.7% of them stated they enjoyed eating. This suggests that more information needed to trace out the evidences behind the food waste.

The study included additional survey questions related to food quality. In this case, more than half of the respondents (65%) believe that food served in the canteen lack variety and foods were repetitive, of similar diet pattern. This was as the main reason behind the leftover. Even though eight out of ten believes that the food served was hot and fresh, still about 77% of them attribute their leftover with the quality of cooking and 89% with the lack of taste and range of flavors. The most common cause of food wastage at the cafeteria were plate leftover, mainly due to quality of cooking and lack of varieties which together approximate come up to 83%. This can be further supported by the 61.2% of the respondents, who have not admitted serving more food than they needed and all respondent believe no spoiled food is served in any of mealtime.

Similar study stated that, the correlation between perceived health risk related issues, socio-demographic variables, and the daily amounts of food waste, almost similar patterns were found for food items (Amman, 2021). With respect to potential drive of food waste, we found that supposed behavioral control was main predictor for food waste. This finding was similar with previous research (Stancu & Visschers, 2016). Participants may have the intent to waste less food, but they must also put in practice their intentions. Perceived behavioral control can be conceptualized as a substitution for actual control and a reflection of skills and abilities (Ajzen, 1991; Manstead and van Eekelen, 1998). Thus, it seems rational that our data identified food quality and behavioral control as a relevant predictor for their food waste amount.

On the study time, Injera/ white and red Teff mixed (Seregna Teff) and bread (white wheat) cereal products constitute the highest and third leftover of all food waste. In the total food waste about 48% count for Injera waste and 12% for bread leftover. Moreover, cabbage wastage found that the second large portion of all the food wastes, which was 23% during that particular survey day. From the pulses family pea and Lentils / Ater Kike and Messer Kike correspondingly) accounted for the smallest share of the food waste, it was 12% and 6% respectively. Other waste such as meat and rice are not included in the case study. This is because it was hard to assign their contribution due to insignificant quantity of their wastage. Therefore, the research indicates that the major types of food wasted in AASTU café are cereals, vegetable (cabbage) and pulses. Some similar results were obtained in various research as well (Betz, 2015). The studies show that vegetables (27%) and starch accompaniments (30%) were dominant in catering companies as a food waste.

Without considering other items, working only to reducing Injera waste per day will lead to save high amount of macronutrients. This is because Injera contribution to macronutrient equivalent loss is relatively higher than the rest of food items. For example, Injera share contribution to carbohydrate equivalent loss stands 65.3%. As a result, working to minimize Injera waste will contribute significant amount, to save equivalent nutrient losses.

The mean difference between female and male for Injera waste, Bread and Messer Wet' were not significant ( $t(348df) = 1.078, P > 0.05$ ), ( $t(348df) = -0.502, P > 0.05$ ) and ( $t(318df) = -0.929, P > 0.05$ ) respectively. Except for the Messer Kike Wet' and cooked cabbage, the mean difference were significant (table-16). However, equivalent macronutrient losses were significantly different. This significant difference indicated the variation was boosted when the loss converted to its equivalent macronutrient loss which are embedded in crude food wastes.

There was a significant difference in macronutrient loss between Female and Male respondent. For example: there were significant differences in carbohydrate equivalent loss ( $t(348df) = 16.8, P < 0.001$ ) in the scores with mean score for Female ( $M = 175.8, SD = 37.5$ ) was higher than Male ( $M = 119.7, SD = 34.0$ ). The magnitude of the difference in the mean was significant. The result indicated that there was more carbohydrate loss in female plate left over than male which need separate intervention to minimize the loss. In Addition, there were significant differences in Energy equivalent loss ( $t(348df) = -2.84, P = 0.005$ ) in the scores with mean score for Female ( $M = 897.9, SD = 203.3$ ) was greater than Male ( $M = 952.9, SD = 188$ ). The magnitude of the difference in the mean was significant. From observed nutrient intake data (Table-19) both

female and male had inadequate food energy consumption while there were about half of their energy daily demand (2000Kcal/day) had loss in the form of plate waste. The report illustrated that, the losses in terms of macronutrient equivalents show more significant different mean value between females and males plate leftover.

AASTU cafeteria's leftover disposal area reflected vast depositories of lost nutrients. In the study year, enough food was discarded at the consumer levels alone to provide 2,000 kcal per day to 23% of its' own consumer adult population. Reducing waste of food may be particularly beneficial for the availability of nutrients currently under consumed in the Addis Ababa region. Although only a portion of this nutritional value can be recovered for human consumption, the magnitude of loss and the associated lost money and resources mean there is great opportunity in focusing on that effort. Quantifying the loss can motivate related investments and support the case for engagement by registered nutritionists with these efforts. The estimates can also serve as a baseline for tracking the influence of interventions. By breaking down wasted foods into their nutritional components, findings can be better compared to specific nutrient requirements. Losses of under consumed nutrients were striking. For example, at the AASTU cafeteria consumer levels alone, discarded food contained enough dietary fiber to fill the gap between actual and recommended intake for 3379 women or 360 men (Table-22). In addition, there were Carbohydrates and Protein loss along with the wasted food in AASTU, which can cover adequate food energy demand of an average 4571 person of its own adult's population. Furthermore, in Addis Ababa which the university located, there were about 27% of food energy deficient households, 19% food poverty level and 14.6 % stunting (WFP and Central Statistical Agency, 2019). And according to WHO Africa report, there are 25000 children in Addis Ababa admitted to hospital every month in need of treatment for sever acute malnutrition (Getahun, 2019). In adequate macronutrient intake encompasses acute malnutrition symptom (Morley, 2021). Which implies that appropriate production and consumption the University can play significant role to reduce previously listed problems in the form of corporate social responsibility (CSR).

Table 22 Comparison of daily nutrients loss with recommended and current intake at population level in AASTU café

Daily population-level macronutrient loss with recommended and current intakes: energy, macronutrients, and under consumed nutrients

Macronutrients	Recommended Dietary Intake (RDA age 19-30 y)	Nutrient Recommended and Current Intakes			Equivalence to Wasted Food	
		Mean current intake in AASTU (age >18 y)	Mean current intake A.A,2020 (age >20 y)	<sup>c</sup> Average gap in dietary intake for adults (AA)	<sup>d</sup> Equivalent number of gaps in dietary intake (3500 of adults)	<sup>e</sup> Equivalent number of recommended intakes (3500 of adults)
<b>Adult Female</b>						
Energy(Kcal)	2000	1740.8	1490	510	3080.8	785.6
Carbohydrates <sup>b</sup> (g)	260	269	193.7	66.3	4641	1183.5
Protein <sup>b</sup> (g)	46	61.4	30.5	15.5	3487.7	1175.1
Total fat (g)	<70	14.3	52	-	-	192.4
Dietary Fiber <sup>a</sup> (g)	25	18.3	18.6	16	5280.2	3379.3
<b>Adult Men</b>						
Energy(Kcal)	2000	1655.2	1788	612	2724.9	833.8
Carbohydrates <sup>b</sup> (g)	260	294	193.7	25	8376.9	7959
Protein <sup>b</sup> (g)	56	75.4	41.7	36	1464.5	941.5
Total fat (g)	<70	14.2	52	-	-	194.9
Dietary Fiber <sup>a</sup> (g)	38	20.2	28.3	13	1542.5	358.9

Table 16 expresses the results from Table 17 in relation to the gap between current and recommended intakes. RDA; Recommended Dietary Allowance based on NHS AI; Adequate Intake.

<sup>c</sup> average gap in dietary intake= RDA-Mean current intake

<sup>d</sup> Population adult's equivalent to the gap in dietary intake calculated as the daily loss per population divided by the gap in dietary intake in Addis Ababa (Assumption 25 % less from adult RDA). The daily loss per population was calculated as the daily loss per capita (from Table 16) multiplied by the size of total population on August 1, 2021 (i.e., 3500). <sup>e</sup> Population adult's equivalent to the recommended intake was calculated as the daily loss per population divided by the recommended intake. For energy, 2,000 kcal/day was used instead of an estimated energy requirement based on age, sex, height, and weight.

<sup>a</sup> Under consumed nutrients in AASTU café' consumer.

<sup>b</sup> Nutrients of public health concern

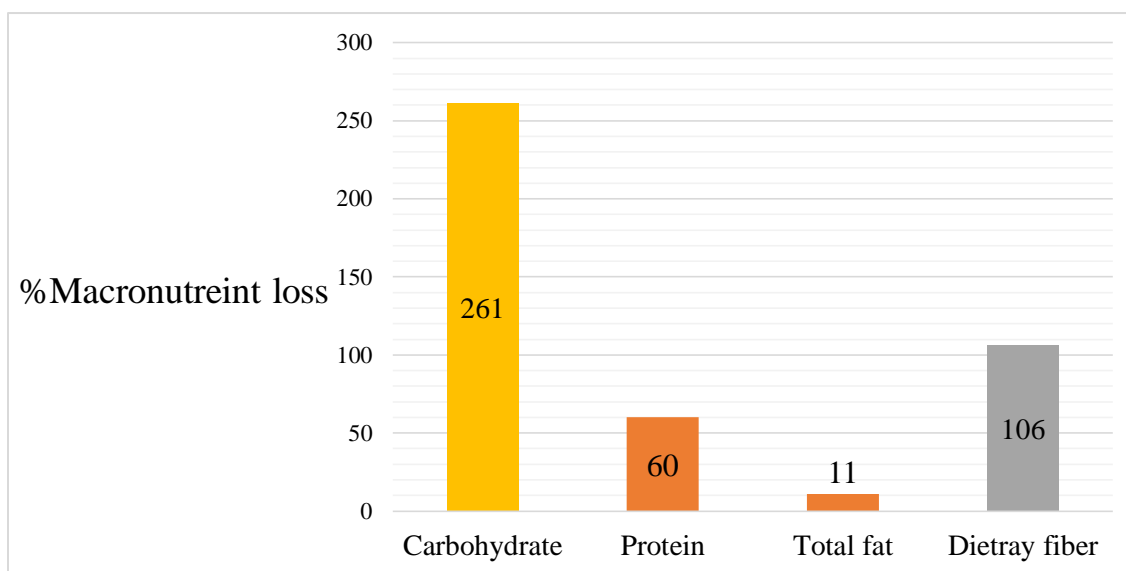


Figure 5 Percent of mean macronutrient loss for each nutrient

Equivalent number of recommended intakes embedded in a daily nutrients loss in AASTU student café, expressed as percentage of AASTU adult café consumer population (age 17-22) in 2021.

The amount of protein embedded in food wasted at the cafeteria levels each day (per population) was equivalent to the Recommended Dietary Allowance protein for 1176 adult women (age 17 to 22 years) or 942 adult men (age 17 to 22 years), which averages to 2476 adults, that was 61% of the adult population consumed in the University cafeteria. The AASTU café' consumer population on August 1, 2021, was 3500 students.

Furthermore, there was significant variation in the food groups contributing to macronutrient losses. For example, for carbohydrate, Injera and Atere Kike Wet' (pea) were the greatest contributor which stands 65.3% and 27% share contribution of the total carbohydrate loss respectively. Whereas for protein it was grains (Atere Kike Wet', Messer kike Wet' (lentils)) and Injera. And for fiber Injera and cereal products have considerable amount of contribution share. The extensive amount of food energy loss at a single University level consumer marks to the need for interventions targeted toward mass catering service provider such as school feeding and University canteens. Share contribution calculated; number of food item wasted gm per day multiplied by its nutrient contents per 100gm divided by hundred resulted amount of nutrient loss along with the food waste. Then percent share will be computed by dividing the total nutrient waste per day.

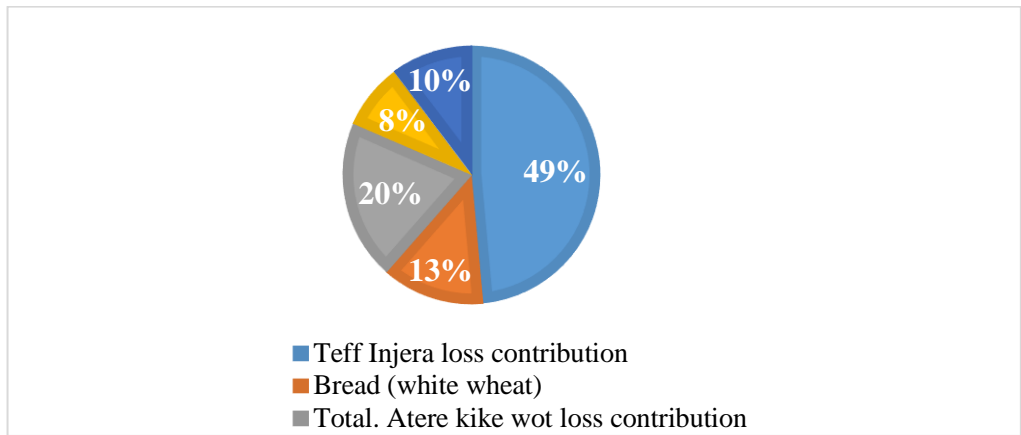


Figure 6 Percent share contribution of food waste for the carbohydrate loss

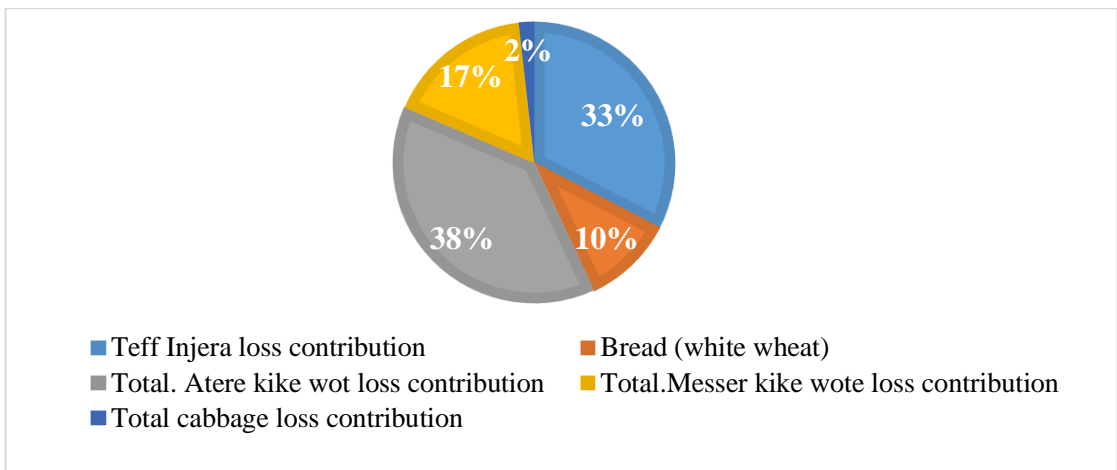


Figure 7 Percent share contribution of food waste for protein loss

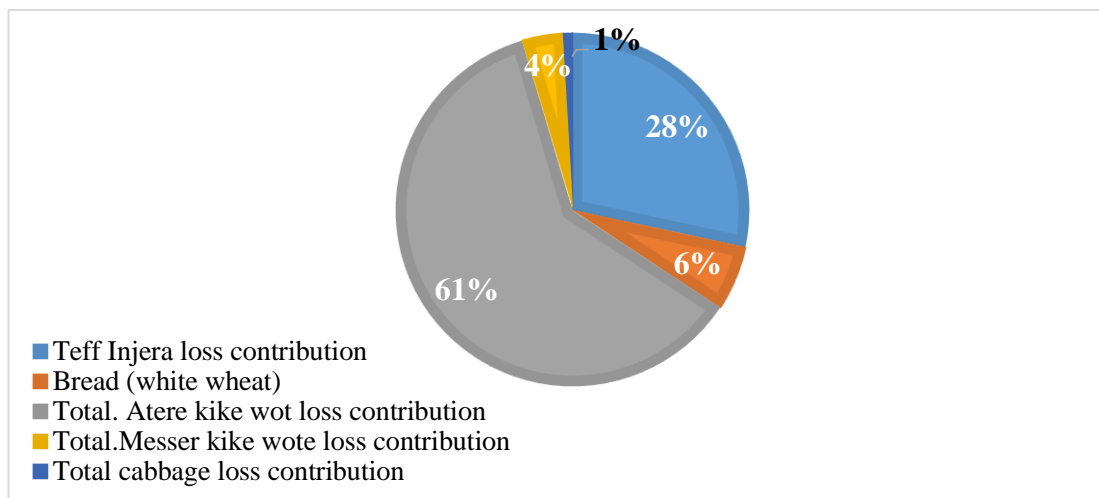


Figure 8 Percent share contribution of food waste to the total fat loss

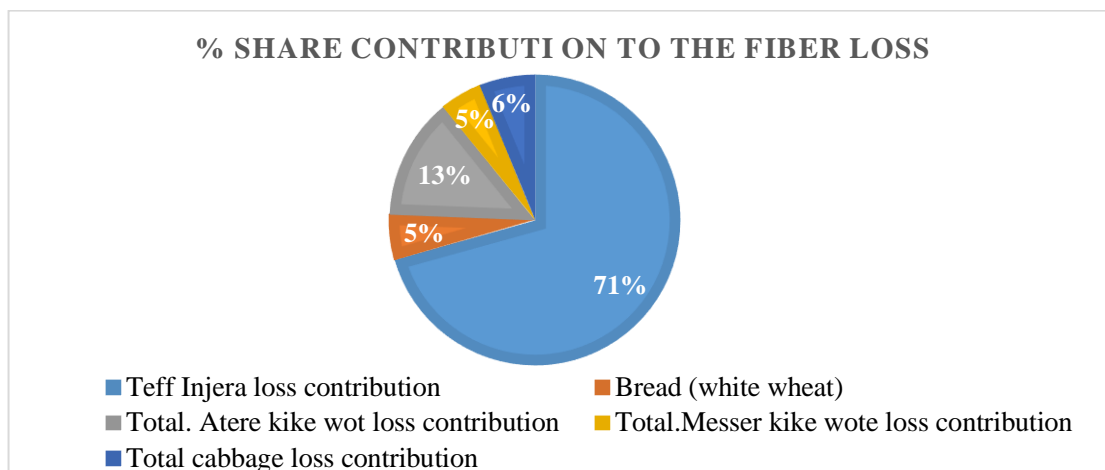


Figure 9 Percent share contribution of food wastes for the total dietary fiber loss

The study also identified energy and macronutrient distribution in AASTU café' adult consumers. These results are in line with intake data of healthy adults (aged 17-22 years), as reported in the National Health Survey (EPHI, 2013). Based on WFP and Central Statistical Agency report, percent of food energy inadequate intake and stunting, had concern for the adult population (WFP/CSA, Comprehensive Food Security and Vulnerability Analysis (CFSVA, 2019). Energy intake was also lower in the general adult population (lower than 2500 Kcal/d for both gender) (EPHI, 2013). In similar study protein energy consumption indicated that below the EAR, However in our findings, which indicated that 47% and 45% loss of EAR for the adults' female and male population. The energy loss in AASTU café consumers as more than half (female 898 and male 953 Kcal/d) compared to that RDA which presents in National health serve report. The Energy loss stands 45 and 48% of the RDA for female and male adult ages. Moreover, the loss in macronutrient En% are comparable, for example the higher macronutrient loss in the survey indicated a 78% and 53% of lower range for carbohydrate adequate macronutrient distribution range (45-65AMDR) for both adult female and male respectively.

Table 23 macronutrients loss comparison with NRV

Age group	Gender	macronutrients	Available for consumption	mean intake	Loss (leftover)	NRV	Loss Compared to NRV
17-30 years	Female	Energy (Kcal/d)	3318	1741	898	2000RDA	45% of RDA
		Carbohydrate (g/d)	613	269	176	260 RDA	68% of RDA
			123 EN%	54En%	35En%	45-65AMDR 66 EAR	78% lower range 47% of EAR
		Protein (g/d)	136	61	31	46 RDA	67% of RDA
			27En%	12En%	6En%	10-35AMDR	60% the lower range
		Total fat (g/d)	29	14	8	<70 RDA	NA
	Dietary fiber (g/d)	13En%	6En%	4En%	20-35 AMDR	20% the lower range	
	Male	Energy (Kcal/d)	44	18	48	25 RDA	More than RDA
		Carbohydrate (g/d)	3318	1655	953	2000RDA	48% of RDA
			613	295	120	260 RDA	46% of RDA
		Protein (g/d)	123En%	59En%	24En%	45-65 RDA 66 EAR	53% the lower range 45% of EAR
			136	75	30	56RDA	53 of RDA
Total fat (g/d)		27En%	15En%	6	10-35AMDR	60% the lower range	
Dietary fiber (g/d)	29	14	8	<70	NA		
	13En%	6En%	4En%	20-35 AMDR	20% the lower range		
	44	20	11	38RDA	29% of RDA		

RDA: based on NHS, Available amounts are computed from table-9

Energy loss among our pooled population of adults were near half of RDA. Energy loss in AASTU-dwelling adult's female and male are often reported 897.9 and 952.9 Kcal/d respectively, while their energy intake indicated under consumption. Hence, risk of malnutrition might be existed in the included studies unless otherwise the gap covered by themselves. Possible explanation for observed energy inadequacy intake could be quality related issues which drives them to left the meal uneaten. Of which Injera, Atere kike Wet' and bread had high percent contribution (65.3, 27 and 17.4 respectively) for equivalent energy loss that could available for intake. A recent study among adults (age 19-30), suggested an energy requirement of 2443 Kcal/day for men and 2000 Kcal /day for women (Borg, Macronutrient Intake and Inadequacies of Community-Dwelling Older Adults, 2015). Observed mean energy intakes of 1740.8 and 1655.2Kcal/day for female and male, respectively, are more in line with these lower reference values and could suggest that our study population was less active than primarily expected. Another point that should be considered are the broad ranges of energy loss (45 and 48% RDA) observed in this study, which indicate that there is a large energy loss among ASSTU café' adult consumers in the form of plate leftover that can cover 45 and 48 % of RDA for adults female and male population.

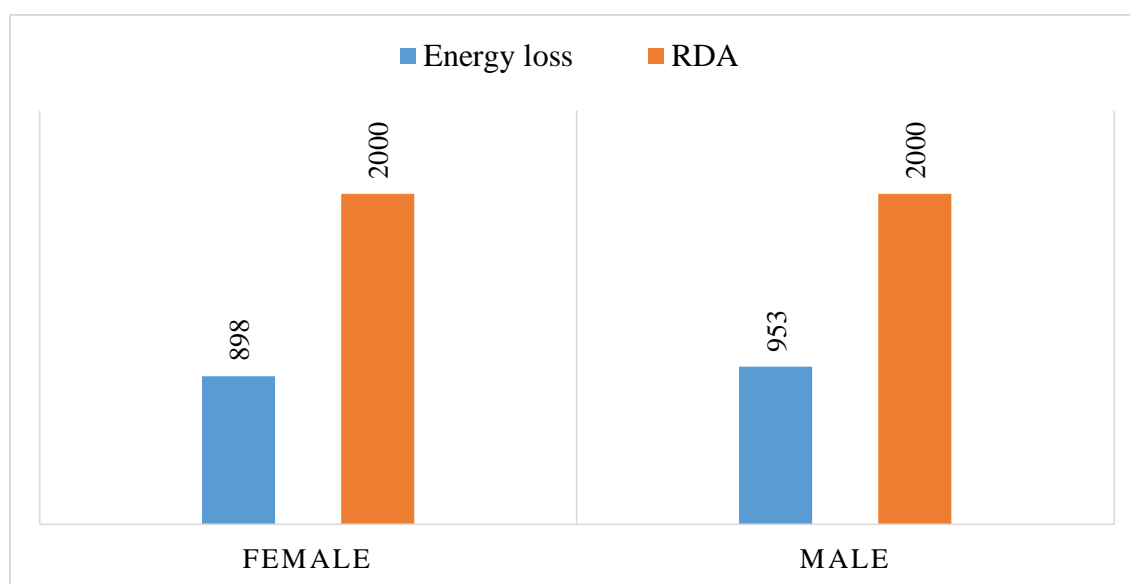


Figure 10 Energy RDA and loss in study adult man and female food leftover, Kcal/capita/day Carbohydrate loss was below the AMDR in the AASTU-dwelling adults. Based on our data, it is however clear which type of carbohydrates are consumed; it would be of added value to know the

intakes of carbohydrate and dietary fiber. As with energy, the reference value used influences the conclusion on food energy inadequate intake. When comparing the loss with the AMDR (45–65%), for instance, the mean carbohydrate loss could cover 78% of the lower of AMDR. Protein loss was in the lower half of the AMDR of 10–35 En%. Recent studies argue that the current recommended daily allowance (RDA) 46 and 56 g/d for adult female and male, corresponding with the EAR of 0.66 g/kg bw/day, might not be adequate for the population (Nutr, 2012) (Volpi, 2013). The RDA is aimed at preventing deficiencies and is based on nitrogen balance rather than achieving an optimal intake to maintain health and function (Volpi, 2013). Protein intake of 10-35 AMDR is beneficial for healthy adults (Kumar, 2017). However in the University café in one day meal service there was protein loss more than half of the lower range of percent AMDR values. Based on the energy reference value of 10.3 MJ/day for men and a bodyweight of 80 kg, the AMDR range (10–35%) would reflect (Millward, 2012)

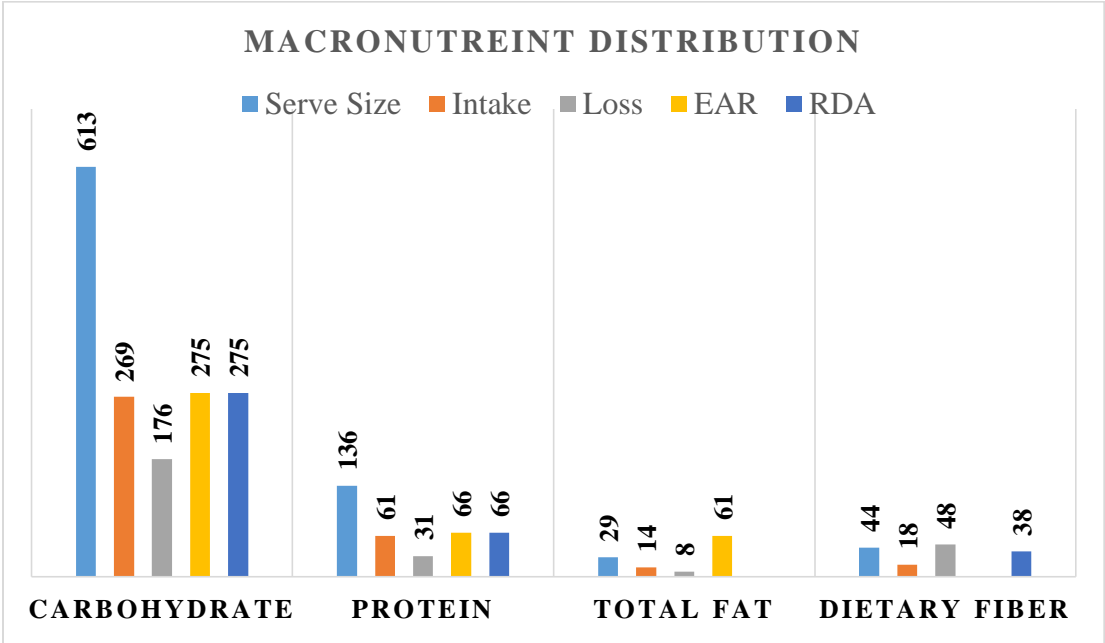


Figure 11 Macronutrients serve size, intake, loss, EAR and RDA in Adult female consumer

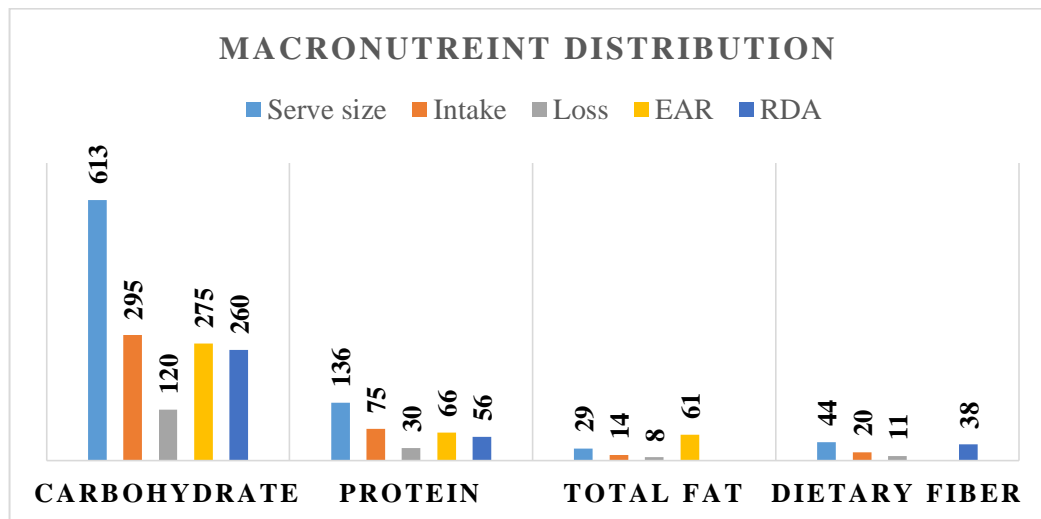


Figure 12 Macronutrient serve size, intake, loss, EAR and RDA in Adult male consumer

Based on comparison food of wastage and intake data (table-21), the study emphasized two student oriented interventions— standardized date labeling (optimizing demand and supply as a mean of portion size) and consumer education—as being particularly cost effective. Implementing adjusted serve amount will tend to decrease the amount of food that goes to landfill and save macronutrients loss associated with wasted food. Hence, there were significant difference in mean observed intake between female and male ( $t(341df) = -7.39, P < 0.05$ ) hence, gender based portion size intervention will be specific strategies to reduce food waste in the consumer level.

The study output should not be taken as inferring that all lost macro-nutrients content could be recovered and fed to people, nor that the food that could be practicably recovered would essentially result in a nutritious diet. Some food will unavoidably be wasted. Food safety concerns are not compromised, and implementing food safety can produce standards to prevent the discard side. However, a portion of macronutrient loss can be prevented through retail and restaurant strategies such as improved prediction of consumer demand, or food packages and portion sizes targeted to consumption patterns. Creating awareness and behavioral shift are also needed, so that there will be responsible consumption and production in the process.

Last, providing the food leftover to the needy is not socially acceptable for human consumption. According to food Recovery hierarchy three uses for such food that are superior to landfilling: feeding animals, industrial uses, and composting (Principato, 2019). Even if it does not address the root cause of food energy inadequate intake in the area, recovering surplus food has an essential minimizing role by satisfying gaps in nutrition intake while diverting food from landfills. However, to attain sustainable food security and address under consumption of key nutrients, it would

preferable implementing wide range of food safety management system from farm to fork. Food recovery may improve availability, but affordability of food energy and essential nutrient demand remains a critical gap. In this research study perspective, a desirable way of reducing losses inherent in plate leftover is to work toward matching production to consumer demand through meal and purchase planning which helps to reduce loss and waste in the first place, rather than finding alternate uses for wasted food.

Food items are conveyed and traded across the globe and additional energy are needed for each activity in the supply chain. Food supply chain consume about 30% of worldwide available energy and off which, 38% is consumed to produce food that is either lost or wasted (FAO, 2015a). Water resources are also required all over the food chain, the mainstream being used at the production stage for irrigation. Food loss and waste result in huge wastage of water resources, particularly in the context of increasing water scarcity and the compounding impacts from climate change.

Furthermore, in financial context, the university loss 10 birr for each 340gm of Injeral waste there was 934.7 kg loss per day which is equal to 27,490.00 ETB loss per day. In addition, there was 197.0 and 359 Kg bread and cooked cabbage loss per day which is equivalent to 6,567.00 and 14,360.00 ETB loss per day respectively. Furthermore, for dry pea and lentils Kike loss can be calculated as: there were 0.226 kg of pea (Atere) and lentils (Messer) dry mass in 420Kg cooked Wet' (Table-4). During the waste inventory day there were 227 and 94 Kg loss per day for cooked pea/ Atere Kike and Lentils/Messer Kike Wet' respectively. Means that by calculation there were near 51 and 21Kg dry mass of Pea (Atere Kike) and Lentils (Messer Kike) equivalent loss per day during the study time. As result the economic loss can be computed by multiplying the loss per Kg by its equivalent buying price per Kg. According to this study market survey, 70 and 100 birr is a tag prices for 1Kg Atere and Messer Kike respectively. Therefore, as per the quotation price, the university lost 3,570.00 and 2,100.00ETB per day for Atere and Messer Kike in its cafeteria. Totally, the University loss 54,087.00 ETB per day along with its food wastage.

The natural resources and inputs needed in the process and the actions related to waste disposal all generate greenhouse gas (GHG) emissions that contribute to climate change. These aggregated impacts make food loss and waste a major contributor to climate change, accounting for about eight percent of total global GHG emissions (FAO, 2015b).

Methane is one of the greenhouse gases. The highest amount of methane gas depends upon the height amount of carbohydrates and sugar that show in the food waste (Nageswara Rao, 2016). A carbohydrate is a biomolecule consisting of carbon, hydrogen and oxygen atoms. It is potential

source for methane (CH<sub>4</sub>) gas formation during decomposition reaction. Methane is potent greenhouse gas that is more harmful to the climate than carbon dioxide (CO<sub>2</sub>).

In addition, the excess nitrogen can be washed from discarded food into waterways during rainy season and can also leach through the soil and into groundwater over time. US Environmental Protection Agency (EPA) report indicates that, high amount of nitrogen can cause eutrophication (excessive concentration of nutrients in a body of water, frequently due to run-off from the land, which causes a dense growth of plant life) of water bodies. This high concentration can lead to hypoxia (“dead zones”), which can poisoned fishes that leads reduction of marine life. And also it can cause harmful algal blooms (HABs) in freshwater systems, which not only disrupt wildlife but can also produce toxins harmful to humans (Jaglo, 2021). Food wastes In AASTU cafeteria accounts 106.8Kg of total protein and based on the laboratory result mixed waste sample contain 1.9 gm per 100 gm therefor, from the total of 1811.2 Kg food waste the 34.4 gm equivalent amount of Nitrogen per day released to the environment. According to Ethiopian conformity directive (98/83/EC) sets a maximum Nitrate concentration in ground water is 50 mg/L.

Groundwater is a common major source of drinking water in several countries and it is often used untreated predominantly from private bores. It has been shown that drinking water in excess of the nitrate limit can result in adverse health effects, especially in infants less than two months of age (Kaur, 2020).

This research is the first in its research topic and area in Ethiopia, hence it makes difficult to compare with similar studies. However plate leftover and energy loss in general was compared with comparable study which takes place in hospital catering. In Peter G. Williams study, the median reported waste was 30% of the plated food weight, 27% of the energy content served and 26% of the protein provided(Williams, 2011).Whereas in this study, the plate leftover were 46.8% w/w capita per day, 35.7% Kcal energy, 30.8% of the protein served 34.4% in AASTU cafeteria in 2021. This discrepancy is likely due to food supply changes and condition of the consumer (consumer type); for example, in the Peter G.williams study was undertaken in hospital catering service while this study use university food zone. In addition, the estimate of 925.4 kcal wasted per capita per day in 2021 in AASTU cafeteria from this analysis differed by only 23% from Marie L. Spiker study of 1,217 kcal per capita per day in 2012 in the catering industry. This inconsistency is likely due to food items changes, quality of food commodities and cooking and minor methodologic differences for example, this study calculated caloric value by using local food composition data series, whereas spiker’s analysis used weight. Furthermore, food portion size determination may differ, and the technology

and skills in the production and service of the food items would also impact on the food eaten and lost.

Estimating the amount of portion size of the consumer would help to have well defined demand to serve the consumer reduced wastage. The catering sector could implement some actions to reduce food waste and associated nutrient loss by offering portion size, appropriate portion size more careful menu planning, or educating their customers (Priefer et al., 2016). Here in this study, it has been shown that individual observed intake between female and male consumer show significant difference. In some cases females mean intake less than male's intake. For example Injera mean intake between female and male has significant difference. The mean Injera intake score for Female (M= 358.3, SD= 86.7) was greater than Male (M=301, SD= 85.5). Hence during serving Injera instead of serving the whole standard weight (340gm or full Injera) to all consumer, available options to take few portion in the table which will help to left Injera in the buffet instead of in the plate. The same is true for bread, slice serving style is recommended while serving the whole bread. This is because there were also significant difference in mean bread intake between female and male ( $t(348df) = -1.4, P=0.05$ ) in the scores with mean score for Female (M= 88.5, SD= 38.2) was lower than Male (M=93.7, SD= 31.3)). As a result, presentation with different size option would help to save the bread wastage.

Cabbage wastage in the AASTU university contribute 23% and 13.7% for the total plate leftover and carbohydrate loss associated in the total food wastage respectively. About quarter of the total plate leftover was composed of cabbage wastage. As result effort is needed to reduce this food item as well. Here in this research, the study found out female took less cabbage than male consumers ( $t(341df) = -7.4, P< 0.01$ ) in the scores with mean score for Female (M= 82.5, SD= 25.2) was less than Male (M=101.1, SD= 21.8). This can be due to various factors including the cooking quality- females more concerned about the preparation and recipes than males (Guerro, 2008). As a result, here also presenting options to choose different portion size will help to reduce the cabbage wastage in the plate.

Managing serve volume size for Ater and Messer Kike Wet' are more difficult related to remaining food items. Therefore altering individual portion size not recommended in this case. Also the mean intake between female and male has no significant difference ( $t(348df) = -0.9$  and  $t(324df) = 0.9$   $P>0.05$  respectively) to consider gender base intervention during serving.

## **5.7 LIMITATION AND STRENGTH OF THE STUDY**

This research analysis is subjected to the limitation of its primary data resource for food wastage. Primary loss assumption that may not be sensitive to change across time-for example change cooking and processing method, food items quality, cooker skill development etc., can change the quantity of food wastage. Limitation in the local food composition data series (EHNRI-1998) is included on top of confines in the underlying food loss data. There are challenges specific to estimating nutrient loss this is because the composition varies within and across food categories, and origin. Hence the actual nutritional value of wasted food may differ according to its state at the time of being discarded. Another challenge is that food may decrease its nutritional value during cooking process.

The specific time of year when a study takes place may affect the waste produced, which can lead to a systematic error. Solutions include sampling throughout the year; or, a study has been undertaken at one time of year, adjusting to account for known variations, for example, household food waste report (WRAP, 2013). Furthermore; laboratory instrument may not be available as such and is expensive for macronutrient identification and quantification. Problem mixing items which have to be measured separately was observed in quantifying macro nutrient lost, by sorting from total food waste. Covid-19 was one of major obstacle to collect data repeatedly as expected. Existing data was missed due poor inventory system.

The strength of this study is that, it assess the first estimate of the loss of a comprehensive set of macro-nutrients across common food items that represent the Ethiopian food supply. This analysis permit for a deep view of nutrient loss, including proportions of loss by food group. In addition, the research point out a call for better national-level food waste and nutrient loss quantification research with regarding to food security, and this study meant to indicate how to quantify the extent of nutrient loss at a national level.

## **6 CONCLUSIONS AND RECOMMENDATIONS**

### **6.1 CONCLUSIONS**

This study is the first to demonstrate the substantial amount of nutrients, including many under consumed nutrients, wasted due to food discarded at the consumer levels of the AASTU food supply. Discarded food can practically be made available for human consumption. Efforts to redistribute surplus foods where appropriate and prevent macro nutrient loss in the first place could increase the availability of nutrients for its own consumer or needy via corporate social responsibility strategy, while saving money and natural resources.

### **6.2 RECOMMENDATIONS**

#### **6.2.1 Prevention**

According to the research data, from AASTU cafeteria food, more than quarter of meal served wasted in the form of plate leftover. Hence, canteen administrator have to consider the exact demand so as to supply the appropriate portion of food to reduce the wastage. From the data Injera and bread cover the large portion of the waste, on the other hand this food items have 26% share of daily calorie intake of adult Ethiopians (WFP and Central Statistical Agency, 2019). In order to reduce the waste by half, the research will recommend to serve as follow.

- A. Offering too much food, Train catering staff to correctly device students' portion and size the dishes. Offer smaller portions with the option to add more at maximum allowed amount.
- B. Offer a range of dish sizes, such as small, regular, big and special sizes for female and male. This measure should be accompanied by simple portion size instructions to the customer, such as ' Maximum net portion size for male "500" for Female "450" gm per serve '.
- C. The maximum amount of Injera and bread intake were 570 gm and 188 gm per day respectively (one full Injera and half, one full bread and half)). Therefore Injera and bread should be provided by slices, cut and role forms. So that, anyone who want to eat less may pick one or two role of Injera and slice of bread which will save the loss from leftover. And also, helps the food to be saved on the buffet instead of wasted as plate leftover which will serve

again in the next meal service. By doing this we can shift the nutrient in to the next plate instead of wasting and losing it.

- D. Know exact amount of consumer before cooking proceed. The number of plate served per day will be determine according to the demand. Here in the study area, observed the student maximum portion size was 570 gm for Injera, 189 gm bread, 198 ml Kike Wet', 180ml Messer Wet' and 130 gm cabbage capita per day. As a result the canteen administration has to prepare the meal based on the above data. Here the amount of cooked Pea Kike and Lentils dry mass (95Kg/420L) are not recommended to reduce from the previous cook amount, however based on estimated portion size determination table15- the concentration has to be changed to 24 gm/100ml( 24% w/v). This will help to cook the meal with quality and increase the tendency to be eaten. This estimated portion size have to be posted on the dining hall and the consumer have to be aware of their portion size per day. However, this should not be set as a restriction because their daily food energy requirement have to be attained. The only thing that matter is to save food which are discarded in the form of plate leftover.
- E. Average food leftover of female and male has no significant diffidence. Therefore, it can be concluded that the drivers and the reasons for their left over have common sources linked with food quality and cooking skills. Which will help to serve the food with good cook quality without gender consideration. However, there were significant mean difference between female and male for the estimated portion amount ((t (341df) = -7.39, P<0.05)). Hence the result indicated that separate intervention for portion size with respect to gender has to be considered without attacking their maximum allowed size. In order to achieve this the university canteen human resources has to be include professional chef and get consult from nutritionist, dietitian or any catering service related professional advisor.

### **6.2.2 Optimization –concept of redistribution to the needy**

Nutrient recovery concept is about recycling the nutrient. As per nutrient recovery stage model, optimization deal with concept of redistribution to the needy. Using proper and standard receiving procedures such as: receiving containers have to be stainless steel, immediate drying and grinding so as to prevent microbial contamination, optimizing the drying temperature, grinding size and good quality packaging process to keep the nutrition value and free from

pathogens and food hazards. In the research, sample drying and milling process have been checked in food laboratory to evaluate nutrition content and hazardous microorganism and the result (Table-11). Giving consumer leftover for needy people directly for immediate consumption may not be ethical and acceptable for human consumption, instead they can donate it for cash which will earn the organization some income from the sale of packed leftover for agro-farms such as cattle and chicken feeds. The university can use the revenue from sale to improve diet quality and variety of meals.

### **6.2.3 Reduction**

In the food waste hierarchy the third possible option to manage the waste is, use the left-over for animal feed. Poultry farms, animal feeds currently use resources from cereals that can be used for human consumption, which could be one reason for the expensive price for chicken, meat and egg. By substituted the feed from human leftover we can reduced the cost of the chicken meat and egg so that the university can use the revenue to balance the inadequate nutrient intake for its own consumer and or for needy who are outside its location as corporate social responsibility (CSR).

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# ANNEX-1

## Crude food waste collecting data sheet

Food Type				Inventory year		Aug-21		
Consumer sex				Location		ASSTU Café'		
Plate No.	Given-per day/head/gram	leftover/gram	Plate No.	Leftover/gram	Plate No.	Leftover/gram	Plate No.	Leftover/gram
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								

## ANNEX-2

### Questioners

An English Questioner Designed to assess the Scio-demographic Status and associated predictor among Institutionalized adults consumer in Addis Ababa Science and Technology University

Dear respondent,

We invite you to take part of this questionnaire regarding plate leftover that could help to determine portion size in Addis Ababa University. Please, kindly requesting you to take 10-15 minutes to answer all the questions. The results of the survey will be treated anonymously and collective way. For the purpose of the present survey food waste is considered food that was purchased by the University for Consumption but was thrown away or i.e. was not consumed.

#### Personal Information:

Q1. Meal Number: 1. NA  2. Applicable

Q2. Sex: 1. Male  2. Female:

Q3. Age: 1. 17-22  2. 23-28  3. 29-34  4. > 34

#### Medical History

Q4. Check the following medical conditions you have  diagnosed with recently (about within 1 month)

- |                               |                          |
|-------------------------------|--------------------------|
| 1. Herat Case                 | <input type="checkbox"/> |
| 2. High Blood Pressure        | <input type="checkbox"/> |
| 3. Diabetes                   | <input type="checkbox"/> |
| 4. Gastro intestinal disorder | <input type="checkbox"/> |
| 5. Renal disease              | <input type="checkbox"/> |
| 6. Liver disease              | <input type="checkbox"/> |
| 7. No at all                  | <input type="checkbox"/> |

Q.5 Medications that restrict food intake

1. Have medication

-----  
2. Have no medication

Q.6 any dietary supplements that inhabit food intake (vitamin and menials).-

1. Have supplements

-----  
2. Have no supplements

Q.7 Food allergies that restrict foods intake

1. Have allergies

-----  
2. Have no allergies

Q.8 any stress

1. Increase food intake

2. Suppress my appetite

**Social History**

Q9. Do you smoke?

3. Yes  how many in all typical days? -----

4. No

Q10. Do you drink alcohol?

1. Yes  how much during the typical days? -----

2. No

Q11. Do your emotion affect the way you eat?

1. Yes

2. No

Q12. Did you fasting or starve yourself?

1. Yes

2. No

Q13. Do you enjoy food?

1. Yes

2. No

**Food quality**

	1.	2	3.	4	5
	Strongly disagree	Somehow	Neutral	Somehow agree	Strongly agree
Q14. The food is served hot and fresh	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q15. The serve has good variety of items	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q16. The quality of cooking is excellent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q17. The food is tasty and flavorful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q18. Service hygiene and quality of food	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q19. Serving too much amounts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q20. Spoil food is serve	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**ANNEX-3**

**MEAL RECIPE FOR DIFFERENT DAYS**

**Recipe-1**

ለተማሪዎች በምግብነት ለወጥ ቤትና ለመስተጻዕድ የበሰሉና ጥሬ ምግቦች ማዘጋጀት ቅጽ

ሪቦስ 19 / 12 / 2013 የተማሪ ብዛት ቁጥር ምሳና እራት 3500

ለ የጋራ ክፍል

ተ.ቁ	ለእራት የሚወጣ ወጪ ዝርዝር	መለኪያ	ብዛት	ተ.ቁ	ለምሳ የሚወጣ ወጪ ዝርዝር	መለኪያ	ብዛት	ተ.ቁ	ለእራት የሚወጣ ወጪ ዝርዝር	መለኪያ	ብዛት
1	ዳቦ ባለ 150 ግራም	በቁጥር	3500	1	እንጅራ ✓	በቁጥር	2000	1	እንጅራ	በቁጥር	3500
2	ባህር	ኪሎ	70+12	2	ዳቦ ባለ 150 ግራም /	በቁጥር	3500	2	ዘይት	ሊትር	25
3	የጃይ ተሳል	ፖኪት	6	3	በርበሬ	ኪሎ	12	3	በርበሬ	>>	12
4	ጃይ ቅመም	በኪሎ	.070	4	አተር ከከ ቀይ ✓	>>	95	4	ጨው	ኪሎ	2+6
5	እንጅራ	በኪሎ	1155	5	ሸር /	>>	22	5	ቀይ ሽንኩርት	>>	80
6	ዘይት	ሊትር	37	7	ዘይት	ሊትር	30	6	ነጭ ሽንኩርት	>>	1.5
7	ጨው	ኪሎ	0+3	8	ጨው	ኪሎ	0+10	7	ዝንጅብል	>>	1
8	ነጭ ሽንኩርት	>>	115	9	ካርት ✓	>>	30	8	ቃርያ	>>	.250
9	ነጭ ሽንኩርት	>>	1	10	ድንች	>>	45	9	ቲማቲም	>>	35
10	ዝንጅብል	>>	.5	11	ቀይ ሽንኩርት	>>	80	10	ምስር ከከ አልጫ	>>	90
11	ቃርያ	>>	2	12	ነጭ ሽንኩርት	>>	1.5	11	አተር ከከ ቀይ	>>	95
12	ቲማቲም	>>	45	13	ዝንጅብል	>>	1	12	ግልግ ባለ50 ግራም	በግሳ	5
13	በርበሬ	ኪሎ	20	14	ቃርያ	>>	.5	13	የአትክልት ቅቤ	>>	.600
14	ግልግ ባለ850 ግራም	በግሳ	7	15	ቲማቲም ✓	>>	40	14	ሸር	>>	22
15	የአትክልት ቅቤ	>>	.600	16	ግልግ ባለ850 ግራም /	በግሳ	6	15	እርዳ	>>	.070
16	ኮርሪም ቅመም	>>	.050	17	የአትክልት ቅቤ	>>	.600	16	ኮርሪም ቅመም	>>	.050
17	መከለሻ ቅመም	>>	.060	18	እርዳ	ኪሎ	.070	17	መከለሻ ቅመም	>>	.060
				19	ጥቅል ጎመን	>>	(492)				
				20	ኮርሪም ቅመም	>>	.050				
				21	መከለሻ ቅመም	>>	.060				

92  
244  
2  
275  
215  
215  
120  
90  
190  
18  
2  
214  
015  
015

## Recipe-2

ለተማሪዎች በምግብና ለውጥ ቤትና ለመስተጻፍ የበሰሉና ጥሬ ምግቦች ማዘዣያ ቅጽ

ግክለኛ 02 / 13 / 2013 የተማሪ ብዛት ለቁርስ ምግብ 2500 እና እራት 3239 ክሪስቲን 260 ሙስሊም

ተቆይታ የሚመጣ ወረቀት	መለኪያ	ብዛት	ተቆይታ የሚመጣ ወረቀት	መለኪያ	ብዛት	ተቆይታ የሚመጣ ወረቀት	መለኪያ	ብዛት
1	ዳቦ ባለ 150ግራም	በቁጥር	3500	1	እንጆራ	በቁጥር	1750	1
2	ሰጠር	ኪሎ	49+19	2	ዳቦ ባለ 150ግራም	በቁጥር	3600	2
3	የሻይ ቅጠል	ፖኪት	5	3	ዘይት	ሊትር	22	3
4	የሻይ ቅጠል	ኪሎ	.050	4	ጨው	ኪሎ	8	4
5	ፍጥ	>>	160	5	በርበሬ	ኪሎ	10	5
6	ዘይት	ሊትር	8	6	ጥይት ሽንኩርት	>>	80	6
7	ጨው	ኪሎ	3	7	ጥይት ሽንኩርት	>>	1.5	7
8	እርዳታ	>>	.070	8	ግንጂብል	>>	1	8
9	የአትክልት ቅቤ	>>	.600	9	ቃርያ	>>	.5	9
10	ጥይት ሽንኩርት	>>	30	10	ጥይት ሽንኩርት	>>	35	10
11	ጥይት ሽንኩርት	>>	.5	11	ድንች ተይ ወጥ	>>	280	11
12	ጥይት ሽንኩርት	>>	20	12	ምስር ከክ አልጫ	>>	90	12
13	ግልግ ባለ850 ግራም	በባላ	4	13	ሽር	>>	22	13
14	ክርት	ኪሎ	30	14	ግልግ ባለ850 ግራም	በባላ	4	14
				15	የአትክልት ቅቤ	>>	.5	15
				16	እርዳታ	ኪሎ	.070	16
				17	ኮርሪማ ቅጠል	>>	.050	17
				18	መከለሻ ቅጠል	>>	.060	18
					አተር ከክ			35
					ምስር ከክ			30
					ሽር			8

1. የሰጠር የሚመጣ ወረቀት በተቆይታ የሚመጣ ወረቀት ብዛት ላይ ማስቀመጥ ይገባል።  
 2. የሰጠር የሚመጣ ወረቀት በተቆይታ የሚመጣ ወረቀት ብዛት ላይ ማስቀመጥ ይገባል።  
 3. የሰጠር የሚመጣ ወረቀት በተቆይታ የሚመጣ ወረቀት ብዛት ላይ ማስቀመጥ ይገባል።  
 4. የሰጠር የሚመጣ ወረቀት በተቆይታ የሚመጣ ወረቀት ብዛት ላይ ማስቀመጥ ይገባል።  
 5. የሰጠር የሚመጣ ወረቀት በተቆይታ የሚመጣ ወረቀት ብዛት ላይ ማስቀመጥ ይገባል።  
 6. የሰጠር የሚመጣ ወረቀት በተቆይታ የሚመጣ ወረቀት ብዛት ላይ ማስቀመጥ ይገባል።

### Recipe-3

ለተማሪዎች በምግብነት ለወጥ ቤትና ለመስተጻዕድ የበሰሉና ጥሬ ምግቦች ማዘጋጀት ቅጽ

ሪብት 19 / 12/ 2013 የተማሪ ብዛት ቀርቦ ምሳና እራት 3500

ተ.ቁ	ለአራት የሚወጣ መጠን ዝርዝር	መለኪያ	ብዛት	ተ.ቁ	ለምሳ የሚወጣ መጠን ዝርዝር	መለኪያ	ብዛት	ተ.ቁ	ለአራት የሚወጣ መጠን ዝርዝር	መለኪያ	ብዛት
1	ዳቦ ባለ 150ግራም	በቁጥር	3500	1	እንጃሬ ✓	በቁጥር	2000	1	እንጃሬ	በቁጥር	3500
2	ሰጫ	ኪሎ	70+12	2	ዳቦ ባለ 150ግራም /	በቁጥር	3500	2	ዘይት	ሊትር	25
3	የሻይ ቅጠል	ፖዩንት	6	3	በርበሬ	ኪሎ	12	3	በርበሬ	>>	12
4	የሻይ ቅመም	በኪሎ	.070	4	አተር ከከ ቀይ ✓	>>	95	4	ጨው	ኪሎ	2+6
5	እንጃሬ	ርኪሎ	1155	5	ሸሮ ✓	>>	22	5	ቀይ ሽንኩርት	>>	80
6	ዘይት	ሊትር	37	7	ዘይት	ሊትር	30	6	ነጭ ሽንኩርት	>>	1.5
7	ጨው	ኪሎ	0+3	8	ጨው	ኪሎ	0+10	7	ዝንጂብል	>>	1
8	ቀይ ሽንኩርት	>>	115	9	ካሮት	>>	30	8	ታርያ	>>	250
9	ነጭ ሽንኩርት	>>	1	10	ድንች	>>	45	9	ቲማቲም	>>	35
10	ዝንጂብል	>>	.5	11	ቀይ ሽንኩርት	>>	80	10	ምስር ከከ አልጫ	>>	90
11	ታርያ	>>	2	12	ነጭ ሽንኩርት	>>	1.5	11	አተር ከከ ቀይ	>>	95
12	ቲማቲም	>>	45	13	ዝንጂብል	>>	1	12	ሣልሣ ባለ50 ግራም	በጣሳ	5
13	በርበሬ	ኪሎ	20	14	ታርያ	>>	.5	13	የአትክልት ቅቤ	>>	.600
14	ሣልሣ ባለ850 ግራም	በጣሳ	7	15	ቲማቲም /	>>	40	14	ሸሮ	>>	22
15	የአትክልት ቅቤ	>>	.600	16	ሣልሣ ባለ850 ግራም	በጣሳ	6	15	እርድ	>>	.070
16	ኮሮሪማ ቅመም	>>	.050	17	የአትክልት ቅቤ	>>	.600	16	ኮሮሪማ ቅመም	>>	.050
17	መከለሻ ቅመም	>>	.060	18	እርድ	ኪሎ	.070	17	መከለሻ ቅመም	>>	.060
				19	ጥቅል ጎመን	>>	492				
				20	ኮሮሪማ ቅመም	>>	.050				
				21	መከለሻ ቅመም	>>	.060				

የተማሪዎች ብዛት በዚህ ቅጽ ላይ ተገልጿል። የተማሪዎች ብዛት በዚህ ቅጽ ላይ ተገልጿል። የተማሪዎች ብዛት በዚህ ቅጽ ላይ ተገልጿል።

## ANNEX-5

ITEM No.	FOOD & DESCRIPTION	LOCAL NAME	COMPOSITION IN TERMS OF 100 GRAMS EDIBLE PORTION												
			Food Energy	Moisture	Nitrogen	Protein	Fat	CHO (inc.fiber)	Fiber	Ash	Calcium	Phosphorus	iron	β-carotene Equiv.	Thiamine
			Calories	%	Grams	Grams	Grams	Grams	Grams	Grams	Milligrams	Milligrams	Milligrams	Micrograms	Milligrams
208	Lentils, Lens culinaris Med.;, flour	Missir, duqyet,	356.6	9.4	3.85	21.8	0.6	66	2.3	2.2	27	262	8.5	6.63	0.41
209	Lentils, Lens culinaris Med.;, sauce, wthout chili	Missir, wet', allyich'a	151.2	70.3	0.75	3.7	8	62.8	1.5	1.9	25	75	3.6	0	0.08
210	Lentils, Lens culinaris Med.;, split	Missir, kikk	355.1	9.8	4.2	23	1.1	62.8	2.4	2.4	36	317	43.1	Trace	0.29
211	Lentils, Lens culinaris Med.;, spilt, boiled	Missir, kikk, nifro	113.1	71.5	1.24	7.1	0.3	20.5	1.3	0.6	16	80	2.2	0.05	0.17
212	Lentils, Lens culinaris Med.;, whole, dried	Missir, difin, dereq	352.2	10.2	4	22.6	1	63.2	4.8	3	68	359	28.3	Trace	0.37
213	Lentils, Lens culinaris Med.;, whole, boiled	Missir, difin, nifro	152.9	61.5	1.59	9	0.5	28.1	2.6	0.9	25	93	2.1	0.04	0.08
214	Peas, field, Pisum sativum L.;, flour	Ater, duqyet	352.2	10.7	3.7	20.1	1.4	64.8	4.3	3	79	309	13.9	Trace	0.3
215	Peas, field, Pisum sativum L.;, sauce, with out chili	Ater, wet', allyich'a	100.6	80.6	0.51	2.8	5.8	9.3	1.2	1.5	61	190	6.8	0	0.02
216	Peas, field, Pisum sativum L.;, split	Ater.kikk	353.8	10.5	4	21.6	21.4	63.7	2.8	2.8	64	347	13.6	Trace	0.51
217	Peas, field, Pisum sativum L.;, spilt sauce, without chili	Ater, kikk wet', allyich'a	162	67.2	1.07	5.3	7.2	19	1.3	1.3	38	119	2.4	0	0.12

<b>Composition in Terms of 100 grams Edible Portion</b>																			
LOCAL NAME	Food Energy	Moisture	Nitrogen	Protein	Fat	CHO (inc.fiber)	Fiber	Ash	Calcium	Phosphorus	Iron	Zinc	Copper	Sodium	Potassium	RE	Thiamine	Riboflavin	Ascorbic Acid
Injera (Gonder/Negede Weyto)	172.00	56.00	0.86	5.40	1.10	36.40	1.30	1.10	34.30	167.40	30.70	0.85	0.29	11.40	176.90	9.40	0.03	0.03	0.00
Injera (Gonder/Negede Weyto)	164.00	55.00	0.65	4.10	0.70	38.30	3.10	1.90	110.70	137.20	37.30	0.75	0.45	24.90	318.80	5.30	0.04	0.05	0.00
Injera (Gonder/Negede Weyto)	165.00	56.30	0.60	3.80	0.80	37.50	1.90	1.60	57.90	128.10	73.00	0.70	0.48	16.80	180.50	2.70	0.03	0.05	0.00
<b>Average</b>	<b>172.89</b>	<b>55.08</b>	<b>0.71</b>	<b>4.45</b>	<b>1.06</b>	<b>37.87</b>	<b>1.77</b>	<b>1.32</b>	<b>69.73</b>	<b>137.26</b>	<b>20.19</b>	<b>0.93</b>	<b>1.29</b>	<b>73.01</b>	<b>200.67</b>	<b>44.79</b>	<b>0.05</b>	<b>0.08</b>	<b>0.19</b>

code	Food description	Energy (kcal/100g)	Protein (g/100g)	Lipid (g/100g)	CHO (g/100g)	Vitamin A (ug RAE/100g)	Iron (mg/100g)	Zinc (mg/100g)
1053	KITA, FLAT BREAD, GENERIC	228.455	5.932	2.077	47.723	0.777	10.033	1.342
1949	bread , SNNP wheat/sorghum	209.460	5.605	0.758	45.543	0.000	7.933	1.110
4025	Com (maize), Zea mays L.: yellow, bread	233.000	5.100	2.200	48.200	5.500	2.900	1.062
4037	Com (maize), Zea mays L.: white, bread	223.400	4.100	2.200	46.800	0.000	2.000	0.946
4105	Wheat, Triticum vulgare Vill.: black, bread	205.300	5.700	0.500	44.500	0.000	19.600	1.776
4115	Wheat, Triticum vulgare Vill.: white, bread	222.000	6.800	0.800	46.900	0.000	2.700	0.405
4125	Wheat, Triticum vulgare Vill.: mixed, bread	199.300	5.500	0.500	43.200	0.000	2.900	1.428