

Mode of consumption and food waste: Determinants and challenges for Tunisian consumers

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ABSTRACT: Food losses play a very important role in efforts to fight hunger, increase incomes and improve food security in the poorest countries. They have an impact on food security for the poorest populations, on food quality and food safety, on economic development and on the environment.

The purpose of the survey is to analyze food consumption habits. The variables used are regional disparity and socio-economic category (age group, monthly food consumption expenditure, consumer preferences for supermarkets, density of meal preparation, preparation for purchases in view of compliance with the needs (rationality)).

Our sample consists of 2004 households over 20 years old; our sample was broken down into 4 age groups, by sex, by 7 regions, by number of families, by number of working families, and by education.

thanks to our sample, we detected the following factors or determinants of food waste; a highest percentage claim that they buy too much in quantities greater than needed, a lower percentage believe that they cook large quantities of meals, a smaller number of consumers claim that they buy food products in a random manner. 74.8% argue that it is the default of poor food preservation. 58% of consumers explain this waste by the fact that food products become non-edible before the expiration date. Tunisian consumers are aware that there is a lot of waste (70% of Tunisian families consider that there is a lot of waste). Unfortunately, only 3.9% of the remaining food is recycled, which represents a very low percentage compared to that spilled in the trash (24%). Nevertheless, 45% of the remaining food is supplied to domestic animals, which explains a lower level of wastage in the north and south than in Greater Tunis (the presence of the activity of raising sheep, chickens and rabbits...). This component is a factor promoting the circular economy.

KEYWORDS: Food waste, food security, consumption mode.

1 INTRODUCTION

Food losses play a very important role in efforts to fight hunger, increase incomes and improve food security in the poorest countries. They have an impact on food security for the poorest populations, on food quality and food safety, on economic development and on the environment. The precise causes behind these losses vary in different regions of the world and are closely related to the geographical location and specific conditions of each country. Food losses relate to food crop choices and patterns, existing infrastructure and capacities, marketing channels and distribution channels, consumer behavior and food habits. The factors that interest us in this paper are those relating to consumer behavior and eating habits.

The consumption of food products constitutes the first concern of the consumer as well as the most important part of the consumption of individuals since it obeys a need, physiological, psychological and social, its non-satisfaction poses a problem for food security and puts in game the human capital variable. Indeed, the maintenance of physical capital (health, food, etc.) is also taken into account in the theory of human capital (G. becker 1964). The individual optimizes his abilities by preventing them from depreciating too much due to the devaluation of his general and specific knowledge or the degradation of his physical and moral health. He invests in such a way as to increase his future productivity and income. Food is a political,

economic and social issue that helps to strengthen sustainable development. Understanding the food and nutritional situation of populations as well as the disparities between different consumer groups is a crucial tool for preventing food insecurity.

The circular economy is a principle forged in the 1960s by the work of Kenneth E. Boulding "The Economics of the Coming Spaceship Earth". It is an economic system of exchange and production which, at all stages of the life cycle of products (goods and services), aims to increase the efficiency of the use of resources and to decrease the impact on the environment, while developing the well-being of individuals.

The health crisis, political instability and war in Ukraine have made food insecurity visible worldwide and in Tunisia specifically. These facts have shown the limits of the institutional response, namely:

- The lack of economic income of the populations concerned, which leads, in conjunction with degraded living conditions, to nutritional imbalances and health risks;
- The charitable foundations of the public policies carried out since the mid-1980s which have led to the fight against food insecurity being misdirected.

The report by the institute specializing in geo-economic issues in the MENA region noted that growing food insecurity in Tunisia has become a determining factor in the country's precarious political situation since 2014.

According to the three-year average of the Food and Agriculture Organization of the United Nations (FAO), 25.1% of Tunisians were in a state of moderate to severe food insecurity in 2018-20, against 18.2% in 2014-16. Although Tunisia has achieved self-sufficiency in dairy products, vegetables and fruits, the country remains extremely dependent on foreign cereal purchases, importing 50% of the cereals used for human consumption and 60% of those used for livestock feed. Nevertheless, Tunisian consumers are somewhat protected from the high cost of these foreign imports thanks to government food subsidies¹.

How much food is lost and wasted today in Tunisia ? and is it possible to avoid food losses? These are questions to which it is impossible to provide precise answers and few studies are currently carried out in this field.

The purpose of our paper is to analyze the habits of food consumption as well as the determining factors. The variables retained are regional disparity and socioeconomic category (age group, gender, monthly food consumption expenditure, consumer preferences for large surfaces, meal preparation density, preparation for purchases for compliance with the needs (rationality)). Firstly, We will discuss the theoretical progress in terms of consumption patterns and food waste. Secondly, we will analyze the international and national scene for these two concepts. Finally, we will discuss our research methodology and the discussion of the results found.

2 MODE OF CONSUMPTION AND FOOD WASTE: THEORETICAL PROGRESS

A concept that appeared in the 1970s, the circular economy is an economic system of exchange and production which, at all stages of the life cycle of products (goods and services), aims to increase the efficiency of the use of resources and reduce the impact on the environment, while developing the well-being of individuals. The very term circular economy appeared in 1990, in the book "Economics of Natural Resources and the Environment" by David W. Pearce and R. Kerry Turner. In recent years, various legislative provisions accompanied by objectives and action plans have sought to promote this type of economy. The circular economy is a principle forged in the 1960s by the work of Kenneth E. Boulding "The Economics of the Coming Spaceship Earth". In 1976, the notion of a loop economy appeared in a report by Walter Stahel and Geneviève Reday for the European Commission and published in a book "Jobs for Tomorrow". The roadmap for the circular economy sets out in operational terms the transition to be made in order to move from a linear economic model "manufacture, consume, throw away" to a circular model which will integrate the entire life cycle of products, from their eco-design to waste management, obviously including their consumption by limiting waste. This includes measures to produce better, consume better, produce less waste and mobilize stakeholders.

The law relating to the fight against waste and the circular economy has been well established in developed countries with a view to accelerating the change in the production and consumption model, limiting waste and preserving natural resources,

¹ « Situation fragile de la sécurité alimentaire au Maghreb : impact de la crise des céréales de 2021 en Tunisie, en Algérie et au Maroc » édité dernièrement par Le Middle East Institute (MEI)

biodiversity and climate. It is divided into five main areas: getting out of disposable plastic, better informing consumers, fighting against waste and for solidarity reuse, acting against planned obsolescence and producing better. It is customary to describe the circular economy in three areas of action and seven pillars. The indicators selected are intended to illustrate each of these areas and pillars.



Fig. 1. Figure 1: Action areas and pillars of the circular economy (Appendix 1)

Indicateurs clés pour le suivi de l'économie circulaire - Édition 2021

The circular model advances the fact that "nothing is created, everything is transformed", proposed by the circular economy aims to develop new ways of producing and consuming in order, on the one hand, to limit the consumption of natural resources and, on the other hand, reintroducing the material contained in the waste into the production cycles. This model is compatible with the project of sustainable development. The circular economy has the advantage of being compatible with the 3 pillars of the sustainable development model, namely the economic, social and environmental pillar. With regard to the first pillar, research work has been able to demonstrate that the potential of CE is a minimum net saving of 380 billion dollars per year in raw materials in Europe, plus the creation of positive value. This concept is based on relocated consumption, support for industrial and agricultural activity in the territories and the development of new sectors dedicated to repair, reuse and recycling. Each reduction of one percentage point in the use of primary resources in Europe is equivalent to around €23 billion in savings for companies, with the potential for job creation of between 100 and 200,000 jobs².

Given the three areas of action of the circular economy, in our work we will focus on the second area "Consumer demand and behavior". Faced with the succession of crises of all kinds, individuals in search of meaning and concerned about environmental, social and political damage are acting and organizing themselves in the direction of regaining control over events. Many practices of reasoned consumption, organic consumption, frugality, sorting, recycling, vigilance and denunciation of unfair practices (green washing, fairwashing), sharing, collaboration, etc. are developing. Indeed, the sharing and/or collaborative economy is a new consumer behavior. As pillars of the circular economy model, they result in greater efficiency of the resources mobilized in the processes. The notions of "sharing" and "collaboration" bring together very different economic methods. If these notions have in common to be based on pooling or collective action, their purposes and operating rules differ. From an economic point of view, pooling can indeed be a gift, loan, barter, hire-purchase, or even joint purchase. All these formulas coexist.

The sharing economy is therefore ambivalent. The idea implicitly refers to the idea of solidarity, mutual aid and conviviality, but the reality actually cuts across very diverse economic forms. Because of this ambivalence, Damien DEMAILLY (2014) considers that the sharing economy oscillates between "utopia and big business with, on the one hand, a libertarian vision born of the social Internet which brings together people wishing to exchange goods and peer-to-peer services to reconnect. On the other, there is the commercial, even ultra-liberal vision, which sees entrepreneurs positioning themselves to develop this new economy for the purpose of profit. It is therefore appropriate to provide clarification on the terms used in the context

² La consommation des ménages | economie.gouv.fr

of the collaborative economy and the sharing economy. The collaborative economy (Perret, 2019) represents all behaviors centered on access, pooling and sharing of goods, services and information in which use prevails over individual ownership.

It therefore contributes to increasing the intensity of use of a good. In terms of organization, this type of economy is facilitated by Internet platforms and the massive adoption of mobile.

The sharing economy refers to co-production communities in which individuals organize themselves to produce a common good. The objective of these communities is not the maximization of profit but the sharing (of knowledge, travel costs, etc.)³. When it comes to waste, consumers are sometimes presented as unconcerned and ignorant: "More in a hurry and less attentive, consumers often misinterpret consumption dates, do not worry about the organization of their refrigerator constantly solicited by the promotional campaigns of supermarkets, often ill-suited to personal consumption", which would seem to exclude the fact that "the" consumer is concerned about waste and acts to reduce it⁴. Food losses correspond to the decrease in the mass of edible foodstuffs observed in the segment of the food chain where edible foodstuffs intended for human consumption are produced. Food losses occur at the production, post-harvest and processing stages (Parfitt et al., 2010). Losses at the end of the food chain (distribution and final consumption) are generally referred to as "food waste", referring to the behavior of distributors and consumers (Parfitt et al., 2010). "Food" losses and waste only concern products that are directly intended for human consumption, excluding animal feed or other products that are not edible. Developing countries are more affected by losses during production; middle- and high-income regions by waste at the retail and consumer level. The food we waste is also money we waste. A lot of money is invested in the production, processing and transport of food products, as well as subsidies offered to companies in the agri-food sector and support for those affected by the negative consequences of food waste.

The international pact against food waste defines food waste as "any food intended for human consumption which, at any stage in the food chain, is lost, discarded or degraded". This practice, a sign of a linear economy, constitutes a loss of direct and indirect resources (raw materials, water, energy). This indicator is part of the targets relating to the 2030 Sustainable Development Goals defined by the UN. Several studies have focused on the economic and social impact of food waste, but few have focused on the determinants and causes of this waste in order to be able to act correctly. Studies (FAO 2012, FAO 2013) have been able to demonstrate that food waste is caused in particular by poor management of purchases, a lack of knowledge of conservation techniques and the distinction between use-by dates and optimal use-by dates. The most wasted foods are: bread, opened products, leftover meals and fruits and vegetables. In addition, food production requires resources: water resources, fertilizers and pesticides and mobilizes land. Considering the entire food chain, energy is also needed for transport, packaging, storage and conservation. When foodstuffs are wasted, it is equivalent to wasting all the resources it took to produce them!

This preservation of resources is part of the foundations of sustainable development. The fight against hunger and extreme poverty is the first Millennium Development Goal, among the 8 goals adopted by the United Nations (UN) in 2000. The scourge between food waste and food insecurity⁵ is growing. Moreover, the later the waste occurs in the food chain, during meals for example, the greater the impact, because before reaching our plates the products have been transformed, packaged and transported, all processes that require Energy. The impact also differs from one food to another: the food that consumes the most water and emits the most greenhouse gases is beef (15,500 liters of water for 1 kg, i.e. almost 4 times more than for 1 kg of chicken).

3 MODE OF CONSUMPTION AND FOOD WASTE: STATE OF PLAY

The FAO has estimated that 1.3 billion tons of food is wasted each year: almost a third of the food produced. Food waste aggravates the negative externalities of agricultural expansion and monoculture by causing unjustified losses of biodiversity (including the disappearance of mammals, birds, fish and amphibians). A study carried out by the FAO (2013), showed that reducing food waste will reduce by 60% the need to increase food production to meet the needs of the population. Quantifying the economic impact of food waste around the world is hard to learn, but some figures put it between \$780 billion and \$1

³ « Activer l'économie circulaire » – Nicolas BUTTIN et Brieuc SAFFRE – Edition Eyrolles 2015

⁴ Extraits du site <http://alimentation.gouv.fr/stop-au-gaspillage-alimentaire>, Ministère de l'Agriculture

⁵ When people "do not have access to food in sufficient quantity and nutritional quality for normal growth and development in order to lead a healthy and active life" we speak of "food insecurity".

trillion per year⁶. The FAO finds that some of it is unavoidable (crops lost to drought or disease, for example), but much of it is completely avoidable. Indeed, she estimates that saving all the money lost in food waste could feed 2 billion people, far more than the number of hungry people in the world.

This study was able to demonstrate that for developed countries, families waste on average nearly \$1,500 of food each year, some even estimate it at more than \$1,700. Nevertheless, food waste would result in health-related costs of approximately \$150 billion from the use of pesticides⁷. In fact, the total social cost of food waste – including health care, food insecurity due to rising food costs, and lost productivity due to nutritional deficiencies – would cost around \$900 billion per year. Per capita food losses in Europe and North America reach 280-300 kg/year. In sub-Saharan Africa, South Asia and South-East Asia, they are 120-170 kg/year. The total production of edible food per capita for human consumption is, in Europe and North America, about 900 kg/year and in sub-Saharan Africa, South Asia and South-East Asia 460 kg/year. Food waste observed among consumers in Europe and North America is, per capita, 95-115 kg/year, while this figure is only 6-11 kg/year in sub-Saharan Africa, South Asia and in Southeast Asia (Figure 2).

Food losses in industrialized countries are as great as in developing countries; in the latter, more than 40% of losses are observed during the post-harvest and product processing phase, while in industrialized countries more than 40% of these losses are observed at the distribution and consumption stage. Consumer food waste recorded in industrialized countries (222 million tonnes) is almost as high as the total net food production recorded in sub-Saharan Africa (230 million tonnes)⁸.

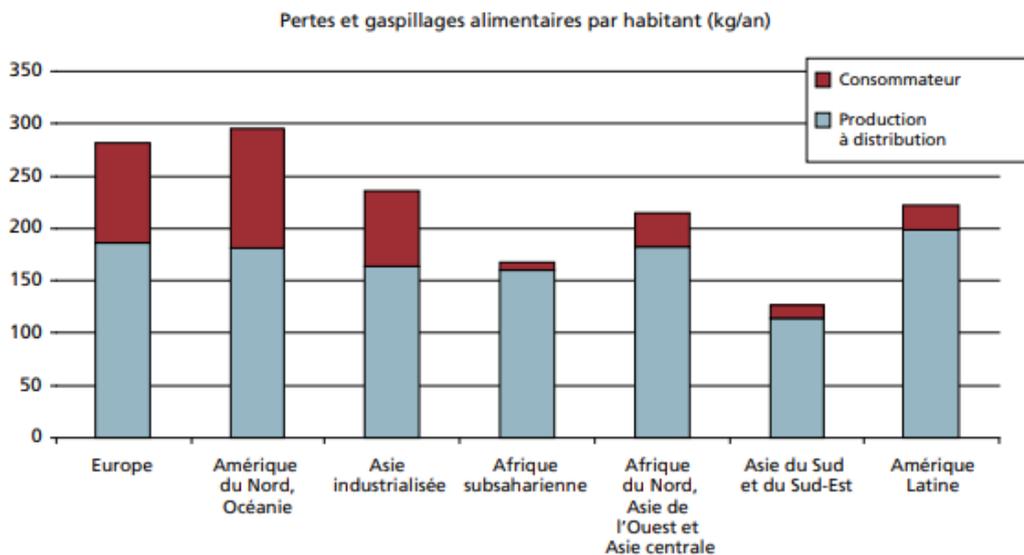


Fig. 2. Food losses and waste per capita and by region, at the consumption and pre-consumption stages

For cereals (Figure 3), wheat is the main crop in high-income countries; the consumption stage registers the highest losses, between 40-50% of the total wastage. In low-income regions, rice is the main crop, especially in the densely populated regions of South Asia and Southeast Asia. In these regions, rather high food losses are observed in the food chain during production, post-harvest and storage operations; lesser losses are seen at the distribution and consumption stage.

⁶ Pertes et gaspillages alimentaires dans le monde - Ampleur, causes et prévention, FAO, 2012, 41 p

⁷ Pertes et gaspillages alimentaires, l'état des lieux et leur gestion par étapes de la chaîne alimentaire, Ademe, mai 2016, 165 p

⁸ FAO. 2012. Pertes et gaspillages alimentaires dans le monde – Ampleur, causes et prévention. Rome

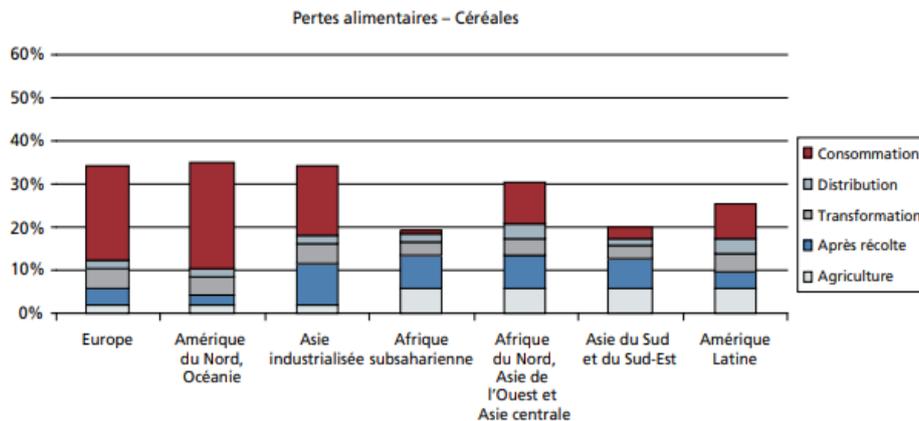


Fig. 3. Cereals - Initial production lost or wasted by region, at different stages of the food chain

FAO. 2012. Pertes et gaspillages alimentaires dans le monde – Ampleur, causes et prévention. Rome

According to the latest survey by the National Institute of Statistics in 2019, Tunisians devote a significant part of their budget to food, i.e. 3871 DT annually per person. Expenditure disparities between regions are very striking, with a higher annual average in large cities such as Tunis 5,810 TND per inhabitant or governorates such as Ariana 5,461 TND, Monastir 5,115 TND. The expenses of the inhabitants of the governorates of Nabeul are 3,919 TND; and for Sousse around 3,774 TND very close to the national average. Consumption is more modest in the central and southern regions of the country, such as the governorate of Kairouan; the average annual expenditure per capita is 2,269 TND. Tunisian household spending is dominated by spending on food (28.9%) and spending on housing (26.6%). The following graph illustrates the structure of household spending in Tunisia in 2019 according to the results of the survey cited above.

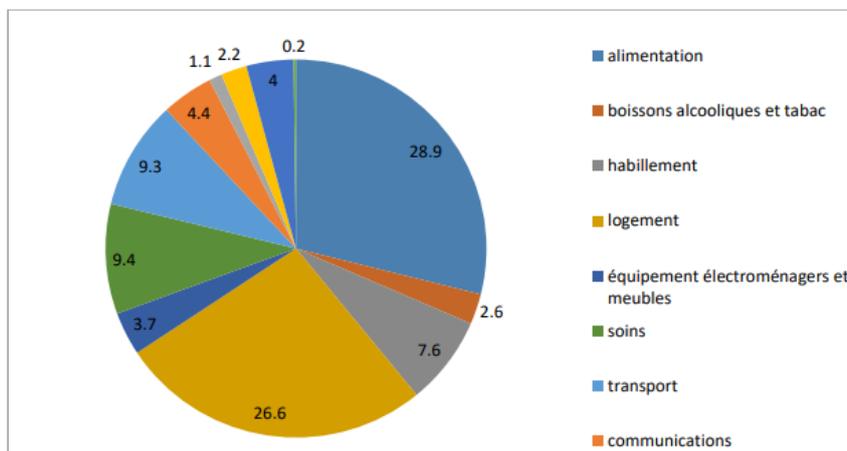


Fig. 4. Structure of Tunisian household expenditure in percentage for the year 2019

Enquête nationale quinquennale sur le budget, la consommation et le niveau de vie des ménages, 2019.

With regard to the structure of consumption, the Tunisians grant an important place to the groups of cereals and derivatives in their diet, headed by durum wheat, which constitutes a basic product in dietary habits. However, this diet tends to change over time. We particularly note that the quantities of cereals consumed/head of inhabitant decreased slightly between 1985 and 2019. The following graph illustrates the evolution of the quantities of cereals consumed/head of inhabitant:

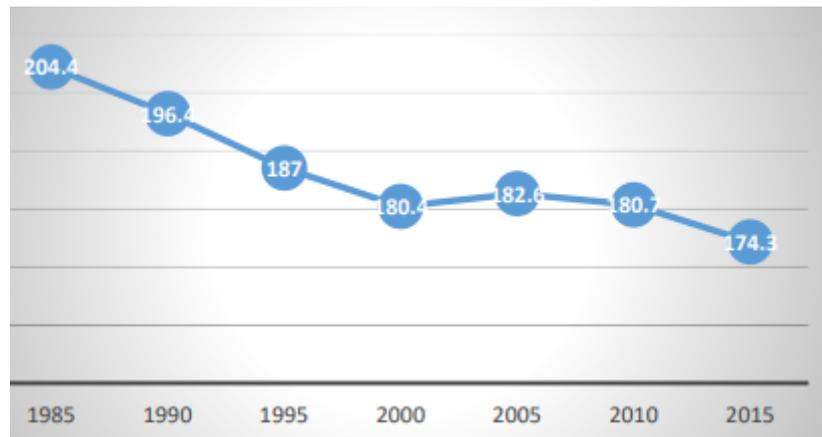


Fig. 5. Evolution of the quantities of cereals consumed per capita

Personal compilation

This evolution is largely explained by the change in the consumption behavior of Tunisians. While the quantities of frozen vegetables consumed continue to evolve (64 kg/inhabitant in 2019 against 46.8 kg in 1985), the quantities of meat consumed practically doubled between 1985 and 2019, going from 17.8 kg / year / inhabitant to 32.5 kg / year / inhabitant and Milk occupies an increasingly important place in food (37.5 kg/year / inhabitant in 1985 to 109.7 kg/year/inhabitant in 2019). The Tunisian citizen's diet is still based on cereals (174.4 kg/year/inhabitant including 63.8 kg of durum wheat and 84.9 kg of soft wheat). However, a diversification of the foods consumed was observed. The Tunisian of today consumes large quantities of meat, milk & derivatives, eggs and vegetables & fruits⁹.

In this perspective we seek to know the food and nutritional situation of the Tunisian population based on the socioeconomic category and regional disparity. The existence of a nutritional imbalance between socioeconomic and regional categories. Without forgetting to bet on the fact that the subsidy of cereal-based food products can encourage waste.

4 MODE OF CONSUMPTION AND FOOD WASTE: METHODOLOGY AND RESULTS

4.1 METHODOLOGY

The purpose of the survey is to analyze food consumption habits. The variables used are regional disparity and socio-economic category (age group, monthly food consumption expenditure, consumer preferences for supermarkets, density of meal preparation, preparation for purchases in view of compliance with the needs (rationality).

Our sample consists of 2004 households over 20 years old; our sample was broken down into 4 age groups, by sex, by 7 regions, by number of families, by number of working families, and by education.

⁹ Principaux résultats des enquêtes et sondages sur le gaspillage alimentaire ; Institut National de la consommation, Tarak Ben Jazia, 2019

Table 1. Distribution of the sample by Region

Region	Sample	Maximum margin of error
Grand tunis	502	4.4%
Nord Est	283	5.9%
Nord Ouest	217	6.7%
Centre Est	464	4.6%
Centre Ouest	249	6.3%
Sud Est	181	7.4%
Sud Ouest	108	9.5%
Sur le plan national	2004	2.2%

Table 2. Distribution of the sample by gender

Sex	Sample	Maximum margin of error
Male	981	3.1%
Women	1023	3.1%
Nationally	2004	2.2%

Table 3. Distribution of the sample according to age

Age range	Sample	Maximum margin of error
Between 20 and 29	493	4.4%
Between 30 and 44	672	3.8%
Between 45 and 59	498	4.4%
Over 60	341	5.3%
Nationally	2004	2.2%

Table 4. Distribution of the sample according to family members

Member of the family	Sample	Maximum margin of error
Between 1 and 2	261	6.1%
Between 3 and 4	842	3.4%
Between 5 and 6	716	3.7%
Between 7 and 8	139	8.4%
More or equal to 9	46	14.6%
Nationally	2004	2.2%

Table 5. Distribution of the sample according to the employability of family members

Family composition according to employability	Sample	Maximum margin of error
No employees	389	5%
Between 1 and 2	1441	2.6%
Between 3 and 4	155	8%
5 and more	19	22.7%
Nationally	2004	2.2%

Table 6. Distribution of the sample according to education of family members

Composition of the family according to the number of schooling	Sample	Maximum margin of error
No	842	3.4%
Between 1 and 2	826	3.4%
Between 3 and 4	314	5.6%
5 and more	22	21.1%
Nationally	2004	2.2%

From these tables, it was noted that the sample taken was larger in Greater Tunis and the Center West. The distribution of the sample according to the age group, noted that the sample is more striking for the age group between 30 and 44 years and between 45 and 59 years, for a number of family members of 3 people. With regard to the distribution according to employability as well as education, we note a very striking sample, respectively of 1441 and 826. Nevertheless, the sample taken records a very large number, the highest, of households with no schooling (no family member goes to school).

4.2 RESULTS

From the results found, it was possible to deduce that food purchases from large and medium-sized stores represent 46% of the target population, while 41% are aimed at small traders. 52% of Tunisian families buy their fresh food in vegetables, fruits and meats. This large number of households that get their supplies from supermarkets once a week explains the importance of waste, despite the fact that fresh food products are quickly perishable.

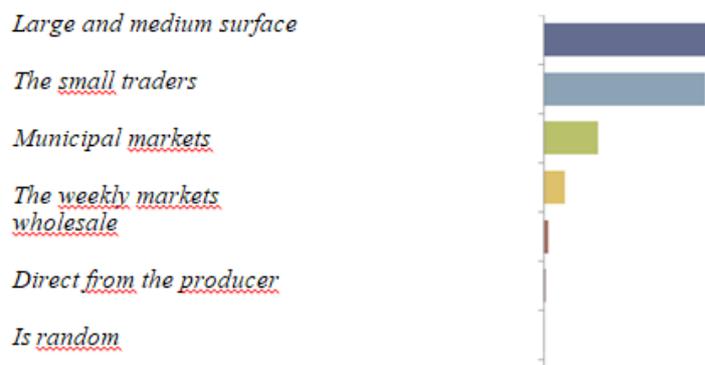


Fig. 6. Frequent place of purchases

The results observed with the crossing of the variables of the region, gender and age group, showed that purchases from large and medium-sized stores are the most important in the region of greater Tunis and the North East, as well as only for the age groups between 45 and 59 in the first place and 30 and 44 in the second place. While for small traders, greater Tunis has the lowest percentage, which largely explains the food waste for this area. Purchases from small traders record a significant percentage for the North-West and South-West. These consumers are in the age group category between 30 and 44 and those over 60 (see appendix 2). A third of Tunisian consumers spend more than 400 dinars per month for food expenses, and 22% spend less than 200 dinars, moreover, the amount allocated is on average 364 DT annually.

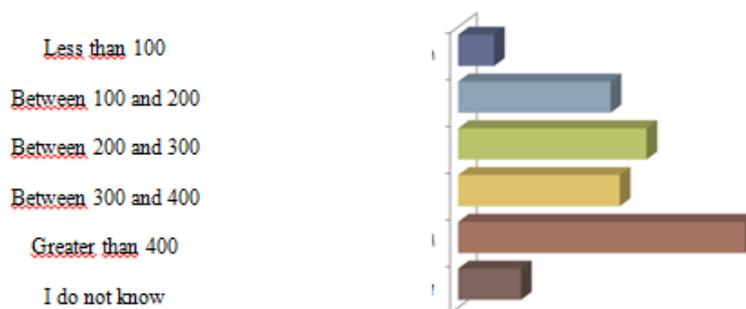


Fig. 7. The amount spent on food expenses each month

Most Tunisian families (79% of the population) prepare meals on a daily basis, while 7.1% claim that they cook four times a week; which once again explains the significant waste of food products. Indeed, this survey was able to note that 25% of the target population claim that they no longer consume the remaining meals, they consume only once; while 24.8 claim that they consume the remaining meals twice a week.

50% of the target population do not prepare for purchases in view of conformity with the needs, which causes random purchases and in large quantities. Indeed, for greater Tunis, only 37.8% of consumers prepare the list of purchases beforehand, while for the south-east region 49% prepare for it. For the category of consumers, with an age group between 20 and 29, for whom it considers that the level of waste is very high, do not prepare a list before shopping (Appendix 2).

70% of Tunisian families consider that there is a lot of waste. 3.9% of the remaining food is recycled, which represents a very low percentage compared to that spilled in the garbage cans (24%). However, 45% of the remaining food is provided to pets.

22% of Tunisian consumers say the number of times they get rid of food and meals per week is once, while 26% say it is once. Nevertheless, 33% believe that they never clean up.

This wastage of food and meals is explained primarily by the waste of bread, indeed through this questionnaire it has been shown that the average quantity of wasted bread or consumption is 15.7%. As a result, 21.0% of consumers say that between 6 and 15% of bread is wasted and spilled in the trash

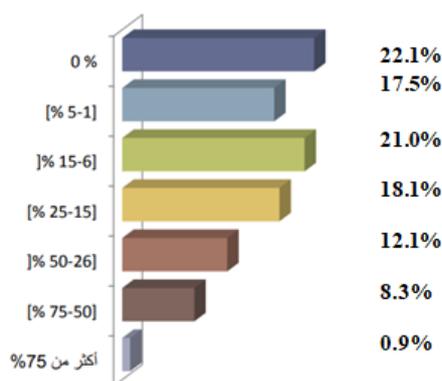


Fig. 8. Quantity of bread (in %) wasted by consumers

Secondly, there is the quantity of wheat and pasta, which represents an average of 10.2% of the quantities of food and wasted meals. It was also noted that 21.0% of consumers claim that a percentage between 6 and 15% of wheat and pasta is wasted and spilled in the garbage cans.

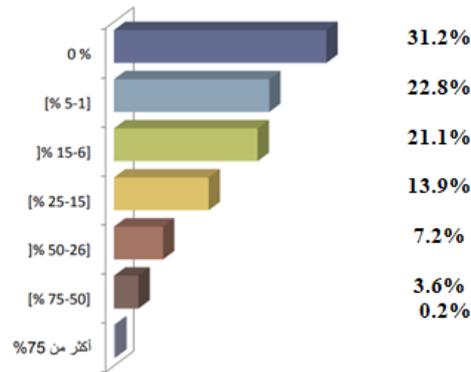


Fig. 9. The amount of wheat and pasta (in %) wasted by consumers

Nevertheless, the quantity of wasted vegetables represents a timid percentage compared to breads, pasta and wheat. Indeed, this quantity represents an average of 6.2% of the quantities of wasted food and meals. It was also noted that 16.4% of consumers claim that a percentage between 6 and 15% of vegetables are wasted and are spilled in the garbage cans.

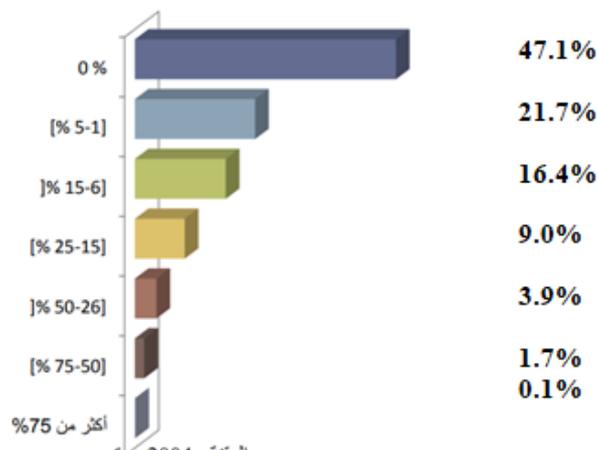


Fig. 10. The quantity of vegetables (in %) wasted by consumers

The quantity of wasted fruits represents a low percentage with an average of 4.2% of the quantities of wasted food and meals. It was also noted that 10.3% of consumers claim that a percentage between 6 and 15% of fruit is wasted and spilled in the garbage cans. While that of milk and its derivatives records an average of only 2.3%.

The quantity of wasted meat represents the lowest percentage with an average of 1.9% of the quantities of wasted food and meals. This being explained by the increase in the price of animal proteins, which affects the purchasing power of the consumer as well as his caution for his mode of consumption of meat. The approximate amount of food waste spilled by Tunisian households each month is 17 TND/month. 23.8% of consumers surveyed state that this approximate amount of waste is between 10 and 20 DT, while 47% estimate that this amount is less than 10 DT.

Thanks to our survey of 2,400 consumers, we were able to detect that 87.9% of consumers claim that they buy too much in excess of what is needed, 87.3% believe that they cook large quantities of meals, 84% claim that they buy random foodstuffs. 74.8% argue that it is the default of poor food preservation. 58% of consumers explain this waste by the fact that food products become non-edible before the expiration date.

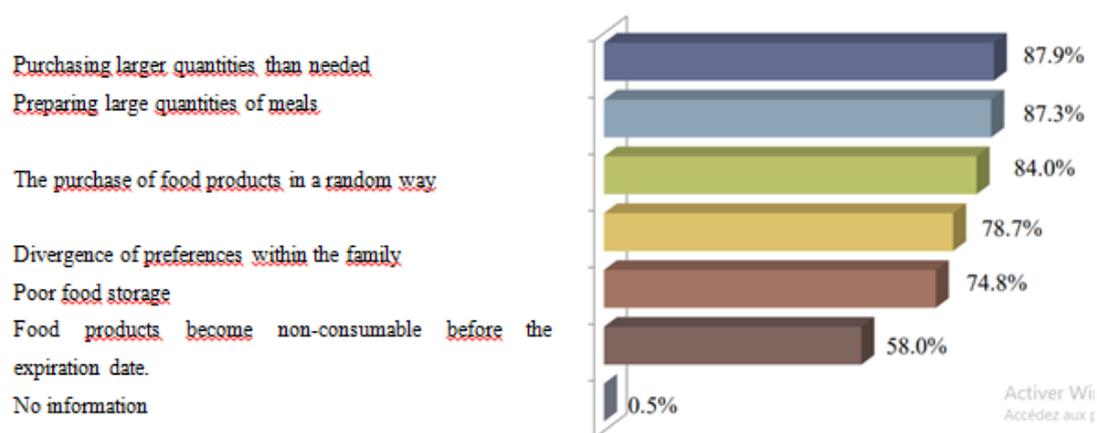


Fig. 11. The main explanatory factors of food waste

The problem that arises is how to encourage a change in consumer behavior with regard to food waste. This behavioral resistance has unfortunately not yet been the subject of specific and in-depth scientific research.

According to our study, we were able to detect that the level of waste of food products is considered high for all regions of Tunisia and especially for greater Tunis and the center west (72.7%) (Appendix 3), as well as for all age groups, and especially those between 20 and 29, who constitute the youngest population and the least aware of the problem of food waste. Awareness campaigns for these young people in universities and cultural centers in favor of the circular economy are essential in order to limit waste and avoid food insecurity.

Tunisian consumers are aware of the importance of the problem and that food waste represents a major economic and social concern. We were able to detect that 98% of the surveyed population are aware of finding solutions to this problem. As a result, public action should focus on this collective awareness and carry out awareness campaigns on these issues in schools and encourage political initiatives to encourage changes in the behaviors that are the source of particularly significant food waste and this by abolishing subsidies. An anti-waste law is essential in the national economy, for a circular economy which includes a series of measures in favor of the fight against food waste. The law should extend the obligations on unsold food to the wholesale trade and reinforce the penalties in the event of the destruction of unsold food that is still edible. It should encourage food donations, while strengthening the requirements in terms of the quality of food donations to associations. Not all consumers know this, yet food remains edible, even if the date of minimum durability has passed ("best consumed before..."). The objective is to establish a list of commitments to be made in order to better inform the consumer about the consumption dates.

5 CONCLUSION

From the results found, it was concluded that food purchases from large and medium-sized supermarkets present the variable or the most explanatory factor of food waste. The large number of households that get their supplies from supermarkets once a week explains the importance of waste, despite the fact that fresh food products are quickly perishable.

In addition, purchases from large and medium-sized stores are the most revealing purchases in the greater Tunis region and the North East, as well as for the age groups between 45 and 59, in the first place, and 30 and 44 in second place.

While for small traders, greater Tunis has the lowest percentage, which largely explains the food waste for this area. Purchases from small traders register a significant percentage for the North-West and South-West. These consumers are in the age group category between 30 and 44 and those over 60 years old.

This leaves us to interpret this regional disparity for the mode of consumption of Tunisians.

With regard to prepared meals, it was found that most Tunisian families prepare meals on a daily basis, while a minority claim that they cook four times a week; which once again explains the significant waste of food products. Indeed, this survey was able to note that 25% of the target population claim that they no longer consume the remaining meals, they consume only once; while 24.8 claim that they consume the remaining meals twice a week.

It has been noted that half of the target population do not prepare for purchases in view of conformity with the needs, which causes random purchases and in large quantities. Once again the regional disparity was noted, but this time in favor of the South East region, of which almost 50% of the target population is preparing for purchases, while a lower percentage for Greater Tunis.

For the category of consumers, having an age group between 20 and 29, of which it judges that the level of waste is very high, do not prepare a list before shopping.

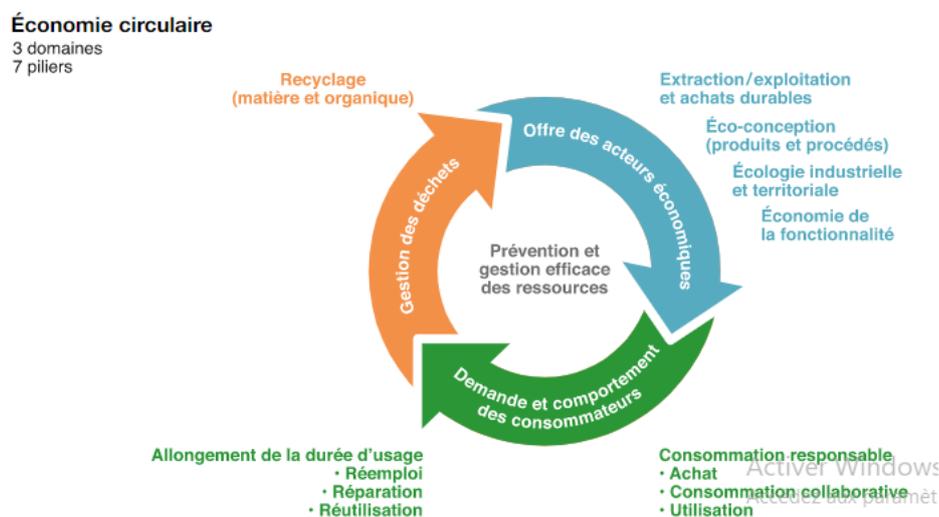
Tunisian consumers are aware that there is a lot of waste (70% of Tunisian families consider that there is a lot of waste). Unfortunately, only 3.9% of the remaining food is recycled, which represents a very low percentage compared to that spilled in the trash (24%). Nevertheless, 45% of the remaining food is supplied to domestic animals, which explains a lower level of wastage in the north and south than in Greater Tunis (the presence of the activity of raising sheep, chickens and rabbits...). This component is a factor promoting the circular economy. This wastage of food and meals is explained first by the waste of bread and secondly, by the quantity of wheat and pasta which represent an average of 10.2% of the quantities of food and wasted meals.

Thanks to our survey of 2400 consumers, we were able to detect the following factors or determinants of food waste; a highest percentage claim that they buy too much in quantities greater than needed, a lower percentage believe that they cook large quantities of meals (87.3%), a smaller number of consumers (84%) claim that they buy food products in a random manner. 74.8% argue that it is the default of poor food preservation. 58% of consumers explain this waste by the fact that food products become non-edible before the expiration date.

According to our study, we were able to detect that the level of waste of food products is considered high for all regions of Tunisia and especially for greater Tunis and the center west (72.7%), as well as for all slices of Tunisia. age, and especially those between 20 and 29, who constitute the youngest population and the least aware of the problem of food waste. Hence awareness campaigns for these young people in universities and cultural centers in favor of the circular economy are essential in order to limit waste and avoid food insecurity.

Tunisian consumers are aware of the importance of the problem and that food waste represents a major economic and social concern. We were able to detect that 98% of the surveyed population are aware of finding solutions to this problem. As a result, public action should focus on this collective awareness and carry out awareness campaigns on these issues in schools and encourage political initiatives to encourage changes in the behaviors that are the source of particularly significant food waste and this by abolishing subsidies.

APPENDIX 1: ACTION AREAS AND PILLARS OF THE CIRCULAR ECONOMY



APPENDIX 2: CROSS-REFERENCED RESULTS OF PLACES OF PURCHASE WITH REGION AND AGE GROUP (IN %)

	Grand tunis	Nord est	Nord ouest	Centre est	Centre ouest	Sud est	Sud ouest	homme	femme	20 à 29	30 à 44	45 à 59	Sup à 60
Large and medium surfaces	57.6	48.1	29.5	50.2	36.1	40.9	34.3	40.7	51.2	46.2	46.6	47.8	42.2
Small surface and retail trade	31.1	41.7	54.8	36.6	46.2	48.6	53.7	46.1	36.4	38.7	42.9	40.2	42.5
Municipal market	8	2.5	6.5	5.2	4	5	1.9	5.3	5.3	6.5	4.5	4.8	5.9
Weekly market	2.4	5.7	6.9	5.8	8	5	6.5	6.3	4.3	6.1	4.2	4.6	7.3
Wholesale	0.2	1.1	0.9	1.3	4.4	0.6	3.7	1.2	1.6	1.6	1.5	1.6	0.6
Direct from the producer	0.2	0.7	0.9	0.4	0.4	0	0	0.3	0.5	0.6	0.3	0.2	0.6
Random	0.4	0	0	0.2	0	0	0	0	0.3	0.2	0	0.2	0.3
I do not know	0.2	0.4	0.5	0.2	0.8	0	0	0.1	0.5	0	0.1	0.6	0.6

APPENDIX 3: LEVEL OF FOOD WASTE ACCORDING TO TUNISIAN CONSUMERS (IN %)

	Grand tunis	Nord est	Nord ouest	Centre est	Centre ouest	Sud est	Sud ouest	homme	femme	De 20 à 29	De 30 à 44	De 45 à 59	60 et plus
Raised	72.7	69.6	68.7	71.3	72.7	70.7	71.3	70.2	72.2	76.3	72.5	70.3	63
Normal	18.7	21.2	19.4	20.5	19.7	18.8	18.5	20.2	19.2	20.7	17.9	18.9	22.9
Weak	6.6	6.7	8.3	4.7	5.6	4.4	9.3	6.8	5.6	2.0	7.0	6.6	10
I do not know	2	2.5	3.7	3.4	2.0	6.1	0.9	2.8	3.0	1.0	2.7	4.2	4.1

APPENDIX 4: USE OF A LIST OF PURCHASES (IN %)

	Grand tunis	Nord est	Nord ouest	Centre est	Centre ouest	Sud est	Sud ouest	homme	femme	De 20 à 29	De 30 à 44	De 45 à 59	60 et plus
Nope	51	46.3	52.1	51.1	51.4	53	45.4	52.7	48.2	46.5	47.9	50.8	60.4
Yes	37.8	47	39.2	40.1	39.8	38.1	49.1	38.2	43	44	42.7	40	32.8
Occasionally	8.6	5.7	6	6.9	6.4	6.6	4.6	6.6	7	7.7	7.3	6.4	5.3
Often	2	1.1	208	1.7	1.6	2.2	0.9	1.9	1.7	1.4	1.8	2.8	0.9
I do not know	0.6	0	0	0.2	0.8	0	0	0.5	0.1	0.4	0.3	0	0.6

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