Enhancing quality-driven food consumption policies in Tunisia

Sonia Boudiche*, Mehrez Ameur**, Zouhair Rached***, Raoudha Khaldi***

Abstract

In Tunisia, food security policies' objectives are increasing production to satisfy the growing demand and reduce the food deficit rate (35% per year). Since 1980, intensive production system and government subsidies for basic commodities were used to enhance food availability. This article aims to analyze food quantitative security policy impact on Tunisian consumption model versus Mediterranean diet and to readjust policies for qualitative food security. Based on five-year National Statistics Institute surveys on household consumption from 1985 to 2015, ANOVA analysis shows the need to address rural and urban consumption separately. Three groups were identified through clustering by consumption deviation degree compared to 1985. Variables of consumption evolution were determined by linear regression: price, income, location, domestic production and a quality factor measuring the conformity degree with Mediterranean diet. In order to achieve a better adherence to Mediterranean diet, new measures and synergy should take place at several levels policy makers, producers and consumers.

Keywords: Food security, Mediterranean diet, ANOVA, Clustering, Linear regression, Tunisia.

1. Introduction

One of the main concerns in developing countries is to ensure food security for their population. This issue has gained importance due to the international price increase, climate change and limited access to natural resources. In order to reach such an objective, a global approach is required not only to increase production and availability of food to satisfy growing demand but also to provide higher quality of food.

Supplying food with the required quality has become a priority seeing the changes observed in food habits in the wake of urbanization and the improvement of lifestyles. These changes have led to a decline in the adoption of traditional Mediterranean diet, which has then led to the appearance of chronic diseases in the region (FAO, 2014).

Several scientific works confirmed that the Mediterranean diet, formerly adopted in the Mediterranean countries, is considered as a nutritional and healthy food model with important benefits for the population (Ridolfi *et al.*, 2020; Dogui *et al.*, 2021; Med diet project, 2017). Declared an "intangible heritage of humanity" in 2010, the Mediterranean model is not a homogeneous model in the Mediterranean area due to

---

* ESIAT: Ecole Supérieure des Industries Alimentaires de Tunis, Université de Carthage, Tunis, Tunisia.
** Ecole Supérieure d'Agriculture du Kef, Boulifa, le Kef, Tunisie.
*** Institut National de la Recherche Agronomique de Tunisie, Ariana, Tunisie.
Corresponding author: soniaboudiche@gmail.com

regional social, cultural and economic variations (UNESCO, 2010; Khaldi *et al.*, 2016). According to Rastoin and Ghersi (2010), the Mediterranean diet is placed at the center of this "territorialized food system". The Mediterranean diet is based on organoleptic and cultural products and contributes in achieving food systems sustainability (biodiversity, social, governance), food security and nutrition in the Mediterranean countries and worldwide. Among its multidimensional benefits are the sustainable consumption and health preservation; the territorial development (adaptation to natural resources, quality linked to origin); the historical, cultural and social anchorage based on local experiences, social preferences and the sustainability of production systems. (Lacirignola and Capone, 2009). However, this model has been lost during the three past decades due to the changing urban lifestyles (Da Silva *et al.*, 2009; Malassis and Allaya, 1996; Lacirignola *et al.*, 2015).

In Tunisia, the main objective of food security policies since 1980 was to increase the production in response to the increasing consumers' needs and to reduce the food deficit (35% on average a year) while ensuring the equilibrium of the trade balance (Khaldi and Naili, 1995). This choice was based both on the adoption and the extension of an intensive production system and on a subsidy policy of basic products to protect the purchasing power of the consumers.

Despite the progress realized in terms of production (quantity and diversification), this model has not succeeded in reducing the food deficit related to basic products, which became a chronic problem, in particular for cereals (60% of deficit). This model also led to the overuse of natural resources (50% of deficit in water), the erosion of biodiversity (almost total disappearance of the local varieties of agricultural species) and the loss of authentic and local products. At the same time, changes in food habits have been observed in transformed food products containing higher energetic values and low nutritional quality which have generated chronic diseases and caused 50 % of deaths in Tunisia (El Ati *et al.*, 2012).

Food security as defined by the FAO "is reached when all the population has, at any time, a physical and economic access to sufficient, healthy and nourishing food allowing them to satisfy their energetic needs and their food preferences for a more healthy and active life" (FAO,1996). This definition refers to another objective, which is the improvement of the nutritional state of the population. More recently, the renewed approach of food security has been how to ensure a sufficient amount of food that "aims at the efficiency during the food chain and at sustainable food practices" (CIHEAM, 2012).

This article seeks to assess the impact of the food security policies on the distortion of consumption of the Mediterranean diet according to a quantitative approach and evaluate the consequences of negligence of food security, according to a qualitative approach, at the levels of both public authorities and consumers.

The specific objective is to analyze the trends of consumption during the past thirty years in Tunisia and compare this with the degree of distortion impacting the Mediterranean food model and identify the socio-economic factors behind this trend. For this purpose, we study, at first, the food security policies focused on the intensification of production and the subsidies in Tunisia. Then, we analyze the impact of food security policies on the evolution of demand. To deepen this subject, we propose an empirical study of the consumption behavior based on clustering methods of foodstuffs and an econometric model to explain the determinant factors of consumption. Finally, we try to propose alternative policies for sustainable qualitative food security.

2. Food security policies in Tunisia

The approach proposed for the assessment of food security is based on the analysis at two levels: supply and demand. The study will focus on the structural characteristics and the degree of consumers' needs satisfaction.

2.1. *Food supply*

In Tunisia, food security is strongly linked to the agricultural production system. The agricultural sector has a great contribution to the economy with a significant part of GDP (12%), and

Table 1 - Evolution of the production for the main food products.

Production (1000T)	1985-1995	1995-2005	2005-2015	2010-2020	Average growth (%) 1985-2020
Durum wheat	790.64	1043.56	1080.30	996.84	17
Bread Wheat	190.45	219.93	248.89	180.84	14
Legumes	57.33	48.15	82.17	86.58	28
Fresh vegetables	1612	2219.95	3048.64	3839.89	38
Fruits	687.62	854.54	1068.11	1156.3	26
Olive oil	131.18	141.55	172.73	194.3	15
Milk products	417.27	802.64	1078.09	1352.02	64
Eggs	1042.73	1408.45	1735.45	1863.39	30
Beefmeat	36.47	48.46	53.21	54.8	22
Sheepmeat	40.72	52.70	58.22	55.7	20
Poultry	54.78	102.27	162.59	182.5	74
Fish	90.7	94.98	109.97	122.1	11

Source: NAOT, 2020, Annual statistics.

employment (16%). The main characteristic of agricultural production is the dominance of the small family exploitations, which account for 80% of the total lands with less than 10 ha owned by old farmers who are often uneducated. Despite their dominance, they control a small proportion of the total land (10%) (NOAT,[1] 2020).

While family farmers produce generally for their own subsistence and sell to local markets, the large and modern exploitations, which cover 90% of farmlands, supply products to the national and international markets. They generally have a higher productivity and efficiency level.

To ensure food security for the population during the past three decades, the government concentrated its efforts on these bigger exploitations using an intensive and modern model of production in order to respond to the increase in demand (35% during the 1985-2015 period due to the demographic average growth (1.5%), the increasing level of urbanization (60%) and income growth (2.8%) (INS, 2017).

Agricultural intensification allows a significant growth for milk (64%), poultry (74%), vegetables (38%) and fruits (26%) (Table 1). However, for basic products such as cereals (14% for bread wheat and 17% for durum wheat), domestic production could not reach self-sufficiency in Tunisia.

Table 2 shows that for these products the self-sufficiency rate remains low (27% for bread wheat and 71% for durum wheat). Consequently, for cereals, Tunisia is always dependent on the world market. Considering that cereals provide 50% of consumer calorie ration (INS, 2017), we confirm that these calories depend strongly on imports (60%). For the other products, the self-sufficiency rate improved strongly especially for milk (98,5%) thanks to the national strategy of the dairy sector applied since 1995 (Ben Said *et al*., 2001; Boudiche *et al*., 2006), legumes fruits, fresh vegetables, beef meat, sheep meat, poultry, eggs due to the development of new production technologies and the introduction of new varieties and breeds. In the case of olive oil, the high rate of self-sufficiency is due to the importance of local production (180,000 T in average).

The high level of olive oil exportation (70% of local production) is usually encouraged by the government in order to cover the food imports, especially sugar, seed oil, coffee, tea and other agro-food products. Although Tuni-

---

[1] National Observatory of Agriculture of Tunisia http://www.onagri.nat.tn.

Figure 1 - Evolution of self-sufficiency rate* of agricultural and food products (%).

$$* \; Self \; sufficiency \; rate \; = \frac{Volume \; of \; Production}{Volume \; of \; production \; +imports-exports} * 100$$
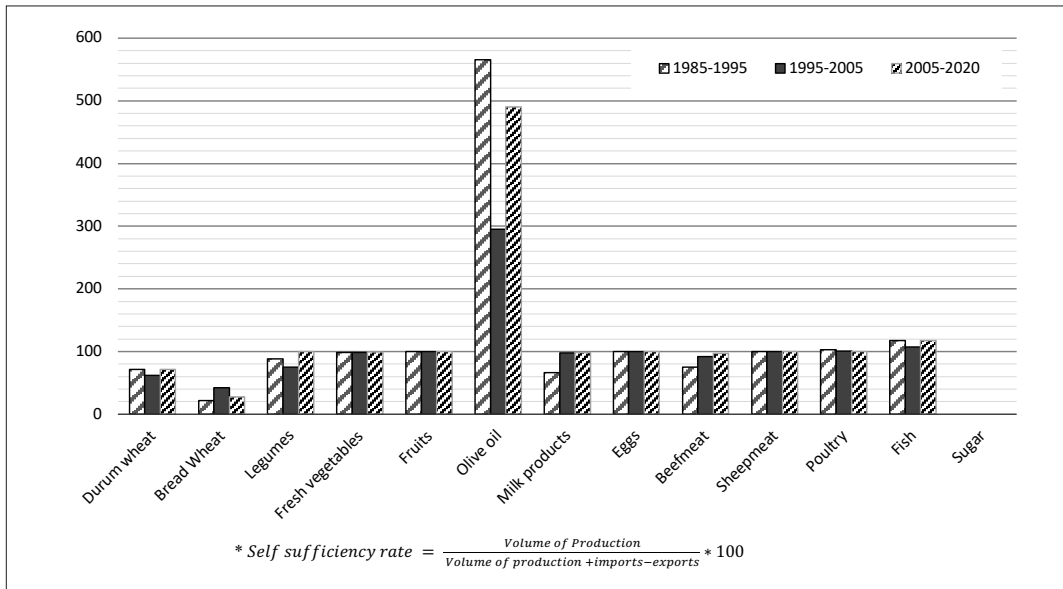
Source: Ministry of Agriculture, Hydraulic resources and fishery (MARHF), Annual statistics, over several years.

Table 2 - Amount of subsidies for food products (2015).

	Sale price (TND)	Cost price (TND)	Amount of the subsidy (TND)	The subsidy (%)
Bread (400g)	200	430	230	46.5%
Semolina (kg)	650	1030	580	56.3%
Flour (kg)	730	1190	560	47.1%
Milk (l)	1250	1420	53.7	4.9%
Couscous (kg)	795	1415	620	43.8%
Pasta (kg)	805	1425	620	43.5%
Seed Oil (l)	900	2500	1600	65.0%
Sugar (kg)	970	1420	450	31.7%

Source: Trade Ministry, 2017.

sia is the second largest exporter of olive oil in the word after the EU, while the domestic consumption is under 6 kg/person/year compared to the seed oil consumption which is more than 22 kg/person/year covered totally by imports. Tunisia is characterized with a high dependence on export earnings from olive oil where the exposure to food security risks is directly related with the olive oil price fluctuations and its competitiveness in the world market. In comparison with other south Mediterranean countries, food security depends more on oil exports and are more pronounced for Algeria, Libya, Egypt and other Arab countries (Lacirignola et al., 2015).

This food security policy, focused on quantitative considerations, is strongly dependent on imports of basic products (bread wheat and seed oil) that the government imports with lower international prices, in its search for the equilibrium of the trade balance (Khaldi et al., 2016). This raises the question of food security in the context of the volatility of international commodity prices.

2.2. *Subsidies policy in food demand*

In order to protect the purchasing power of consumers, the government grants direct subsidies for basic food products (bread, flour, pasta, sugar, milk, seed oil) considered essential in the Tunisian diet. The food subsidies represent the largest part of the total subsidies in Tunisia (70%) with a value of 2100 million TND[2] in 2020 where cereals constitute 78% of the total and 20% of which has been allocated to seed oils from the nineties until today.

By creating the general box of compensation (CGC) in 1970, the government could finance subsidies on the prices of basic foodstuffs. According to a study carried out by the ABD in 2013, this has led to changes in the eating habits of both low and high income social categories, with an increasing trend towards subsidized foodstuffs with low nutritional value (soybean, rapeseed, sunflower oil, etc.) at the expense of other healthy food such as olive oil (ABD, 2013). The attraction of these subsided products such as vegetable oils is explained by their price that is lower than that of olive oil (a gap of 1 to 3) and the communication campaigns in favor of these oils. In 2019, Tunisia imported 160,000 tons of seed oils whose subsidy expenses reached approximately 250 million TND. According to the Ministry of Trade and Export Development, the state subsidy is 1.6 TND per liter, i.e. 65% of its actual value, knowing that the price of a liter of vegetable oil, excluding subsidies, is 2.5 TND sold at 0.9 TND (NOAT, 2020) while Tunisia is ranked the second olive oil exporter after the European Union with an average of 190,000 tons in 2020 (Arfaoui *et al.*, 2021).

The amount of these food subsidies reach 2400 million Dinars (TND) in 2020 (Figure 2) and covers 46.5% for bread, 56.3% for semolina, 43.8% for pasta and 50% for seed oil (Table 3).

In general, the consumption of high-calorie foods, carbohydrates and lipids was encouraged instead of healthy products such as olive oil, durum wheat, vegetables and legumes, the consumption of which in the last period increased in both urban and rural areas (Figure 3).

Moreover, these subsidies still apply to the whole population and not only to the disadvantaged, the poor and marginalized categories. In 2015, the last national survey on consumption and budget (INS) highlighted that Tunisian poor households received only 12% of the subsidies compared to 34,5% in favor of the wealthy population (INS, 2017).

This social policy, adopted since 1970 helped ensure the food security of the population but contributed to changes in consumer behavior.

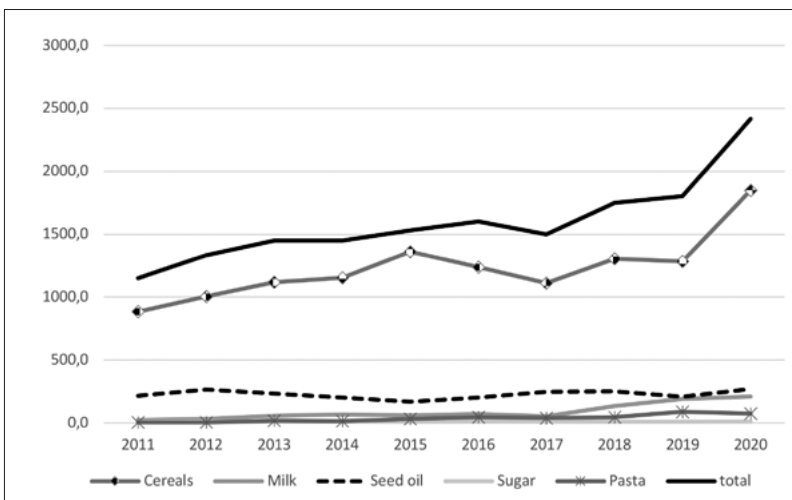In fact, the calorie portion reached an average

Figure 2 - Evolution of food subsidies in Tunisia (Million DNT).

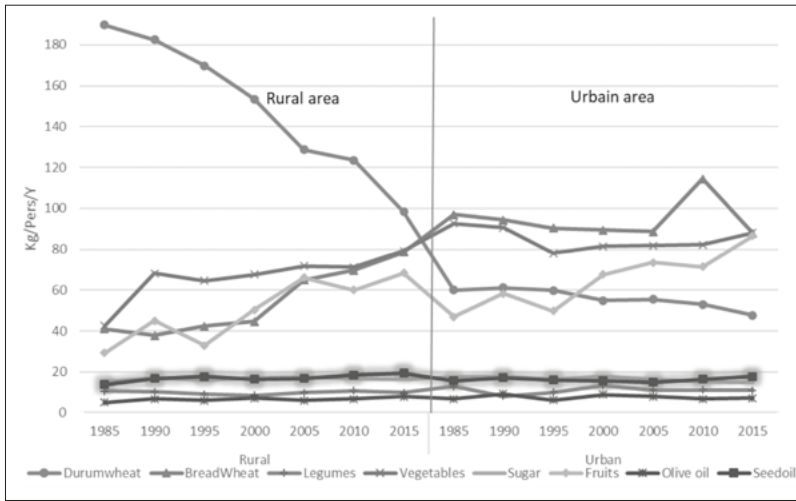*Source: Trade Ministry, several years.*

---

[2] 1 TND= 0,308 EUR.

Figure 3 - Consumption trend by product at national level (Kg/person/year).

Source: INS, 2017; Five-yearly on national household consumption survey.

of 3500 Kcal/day/person (INS, 2017). However, 54% of calories came from cereals and 17% from seed oil which explains the nutritional transition (Khaldi *et al*., 2016).

In Tunisia, the chronic diseases associated with food are currently increasing causing 60% of deaths. Obesity has affected half of the population (33.7% overweight and 26.2% are obese (Ministry of Health, 2019; Dogui *et al*., 2021), which is twice as much as the world average (11.7%) (FAO, 2014). Cardiovascular diseases affect 28.7% of the population and diabetes 18%. Other factors also cause these diseases, especially the new lifestyles on the back of women's employment that accounts for 45% of the total workforce. This has an impact on consumer habits which are geared more towards the easy ready-made food products (local or imported) which are underpinned by strong marketing campaigns made by the large distribution through supermarkets and hypermarkets more present in urban areas. At the same time, out of home meals which are becoming more common strengthen consumption of high-calorie food.

The next step of this study proposes to verify if food security is in conformity with the nutritive and health requirements for the population and tries to evaluate the impact of food policy on consumer behavior. The impact analysis is appreciated through the degree of distortion with the traditional and healthy Mediterranean diet and the socio-economic factors determining this transition.

3. Methodology

The data used in this analysis is from the national consumer survey (realized every 5 years starting from 1985 by the National Institute of Statistics: INS). The household consumption of Twenty-eight products in global, rural and urban areas are used.

As a first step, an ANOVA (analysis of variance) was applied between the rural and urban areas in order to prove if the use of global consumption offers a good approximation (weighted average between rural and urban consumption) (Annex 1). Results reveal a significant difference in food consumption evolution between urban and rural zones concerning certain products (durum wheat, bred wheat, fresh vegetables, meats, fish, milk, eggs, coffee and tea. However, there were no differences in the remaining products (legumes, fruits, poultry meat, fresh milk, olive oil, seed oil and sugar).

This first result indicates that the use of global quantities consumed (weighted average of rural and urban areas together) will not allow us to draw relevant conclusions on the consumption trends during the twenty years studied since 1985. These differences of consumption trends in rural and urban areas can be explained by factors related to the economic, social and cultural conditions of each environment. Thus, for the rest of analysis rural and urban consumption are used separately.

The quantities consumed of Twenty-eight selected products are measured on different units conforming to the nature of each product (like bread, eggs, etc.) causing a problem when all quantities are treated together. To avoid this problem of unit measures, an alternative was adopted to replace the quantities consumed by the consumption evolution rate (CER) considering 1985 as a base year calculated as follows:

$$CER \text{ of year } n =$$
$$\frac{Consumption \text{ of year } n - Consumption \text{ of } 1985}{Consumption \text{ of } 1985}$$

After calculating the CER, we reapplied an Anova analysis comparing variances between rural and urban areas using the CER, to prove the stability of data. The results indicate that among 28 selected products, only two (olive oil and coffee) showed a significant difference in consumer behavior which confirms the efficiency of using this rate.

In the next step, we used the Hierarchical clustering method by regrouping foodstuffs in homogeneous groups based on CER during the period 1985-2015. Hierarchical clustering was realized by the SPSS software (V 20).

Finally, we tried to identify for each cluster of foodstuffs, the determinant factors of consumption by establishing a demand function including: price, consumer income and geographical area. We also introduced domestic production to verify the link between national production and consumption. To check if consumers are aware of the benefits of the Mediterranean diet for their health, quality of food products was introduced as a qualitative variable (dummy variable 1 if the product conforms to the Mediterranean diet and 2 if it does not).

The "double logarithmic function" was used to estimate a demand function in order to interpret the estimated parameters such as elasticity (income and price). (Khaldi $et\ al.$, 2009; Khaldi $et\ al.$, 2007). The reduced functional form of the model was:

$$C = f(Y, P_i, P_j, M, s) \qquad (1)$$

The linear regression function was:

$$LogC_i = Cte + \alpha_1 LogP_i + \alpha_2 Log(PR_i) + \alpha_3 Log(Y) + \delta_1 A + \delta_2 Q \qquad (2)$$

Where
Cte: constant of the model
C_i: Consumption of product I
P_i: Price of product I
PR_i: National production of product I
Y: Annual Income of the consumer
A, and Q are qualitative variables indicating respectively area of habitation and the quality of the product (depending on its conformity with the Mediterranean diet) introduced as a variable dummy.
α_i and δi are the parameters to be estimated.

The data for production are extracted from statistical annual series published by the Ministry of Agriculture during the period 1985-2015. With regard to demand, we analyzed the evolution of household consumption for all food products. The data of consumer's income was provided also from INS's national survey during the period 1985-2015 (INS, 2015).

The model was estimated for each foodstuffs group using the Least Squares method (LS) (Eviews.5 software).

4. Results and discussion

4.1. *Clustering of foodstuffs according to the evolution of their consumption*

The CERs of the products were analyzed by Hierarchical Classification Average which made it possible to bring out 3 homogeneous groups. The common factor at the level of each group is the degree of evolution of its consumption compared to the reference year (1985). Indeed the consumption of certain products changed little, even decreased. On the other hand, for other products, the consumption increased moderately. For certain products one noted very high increases compared to the consumption of 1985. It is according to these evolutions that one interpreted the products of each group.

Clustering analysis showed three homogeneous groups (Table 3) and Annex 2:
Group 1: with low and negative growth, constituted by cereals, vegetables, beef meat and sugar;
Group 2: with medium growth, constituted by dairy products, fruits, seed oils, ovine meat;

Table 3 - Hierarchical clustering.

Cluster 1 (6 products)	Cluster 2 (5 products)	Cluster 3 (3 products)
Durum wheat	Milk products	Poultry
Bread wheat	Fruits	Fish
Legumes	Olive oil	Eggs
Fresh vegetables	Seed oil	
Sugar	Sheep meat	
Beef meat		

Source: Our calculation from SPSS.

Group 3: with high and positive growth such as poultry, fish and eggs.

4.2. Distortion of consumption with the Mediterranean food model

Group 1: Table 5 shows that rich fiber products (durum wheat, legumes) with positive effects on health were identified with a negative rate of evolution. However, concerning bread wheat and sugar with negative effects on health, results showed that their consumption did not increase. This constitutes a positive indicator as these are unhealthy high-calorie products (Khaldi and Saadia, 2017). Despite the fact that these two products are subsidized, their consumption has not increased because Tunisian consumers have reached a saturation level. On the other hand, referring to demand theory, an improvement of income does not increase the consumption of these basic products.

For beef meat included in group 1, and not recommended in the Mediterranean diet, the negative trend is due to the highest consumption price index (Ameur et al., 2016; Boudiche et al., 2015). The vegetables considered with a positive effect on health showed a low evolution rate.

In relation to food transition, in the first group we confirm that the subsidy policies adopted by the Tunisian government increased the consumption of high-calorie products to the detriment of healthy food products, indicating a change in the traditional diet of the Tunisian consumer.

Group 2: with medium growth includes fat products such as sheep meat and seed oil with a negative effect on health. The consumption of sheep meat has increased in spite of its negative effects

on health. This could be explained by the importance of this food product in Tunisian culture (religious links). However, scientists have proven that high quantities of sheep meat consumption could damage health (cholesterol, important protein source, etc.). Nevertheless, sheep meat has always been present in the Mediterranean diet.

The medium evolution also concerns olive oil which, in fact, must have higher evolution taking into account the volume of production in Tunisia and its benefit for health in accordance with the Mediterranean diet. Regarding vegetable oils, the increase of olive oil price and the increase of the exported volumes led to a substitution of olive oil by subsidized seeds with low price. Consequently, olive oil, which is a main component of the Mediterranean diet, is less consumed in Tunisia (7,4 kg/person/year in 2015) compared to seed oil (18 kg/person/year); (Arfaoui et al., 2021).

Concerning dairy products, Tunisian consumption is oriented more to highly processed products (particularly, yoghurt and cheese) to the detriment of those traditionally transformed especially in rural areas.

Fruits are more consumed by Tunisians as a result of the evolution and diversification of their production encouraged by the government at the agricultural level. This constitutes a positive indicator of food transition in conformity with the Mediterranean diet.

Group 3: with high and positive growth, we find eggs, poultry and fish. The Tunisian government authorities have strategically promoted the production of this kind of product since the 1980s. This boosted the production of such products and generated an increase in demand. Tunisians have consumed higher quantities of poultry in the past years (especially after the revolution of 2011) as a consequence of the price increase in red meat. Poultry, recommended by nutritionists, represents a direct substitute of red meat because its consumption increased from 4.5 to 15.2 kg/person/year in the period 1985-2010 while beef meat decreased from 5.2 to 2.9 in the same period.

For fish, the high evolution concerns the cheap species (sardines and mackerels) and especially blue fish (such as gilt-head bream and wolfish) from aquaculture which has developed in the

last years (5.000-10.000 T/year) to provide the market with other protein sources. However, compared to other Mediterranean countries, the quantities consumed still remain low at the national level (7,4 kg/pers/year in 2015 in Tunisia) compared to a similar producer, Greece, where consumption is more than 16,8 kg/pers./year.

4.3. *Impact of socio-economic factors and quality on consumption trends*

The assessment of the demand function for the three groups of food products was realized by the method of Least Squares (LS) (Eviews.5 software). The parameters estimated for each group are shown in Table 4.

Table 4 shows that the chosen variables account for 92%, 86% and 96% of the demand variation of the foodstuffs for groups 1, 2 and 3 respectively.

As the functional specification of the model is in double log, the parameters related to prices and income is their elasticity. All the price's elasticities present negative signs indicating that the quantity consumed decreases when the price increases. The highest direct price elasticity is shown in group 1 (-1.26) which means that the demands for those products are very sensitive to their price variations. Products of groups 2 and 3 revealed inelastic demands due to their lower elasticity (0.83 and 0.88 respectively).

These differences in elasticity values between groups seem to be contradictory, especially for the first group dominated by basic commodities (durum and soft wheat, sugar, legumes, fresh vegetables and beef meat). The theory predicts

the lowest values of elasticity for basic products indicating no changes in their demand. The Tunisian policies for cereal products and sugar (price setting and subsidies) are the main factors of these results. In fact, low prices for these products encourage their consumption as they are considered cheaper compared to other products without subsidies. This social policy, applied since the 70s in order to protect the purchasing power, initially for the poor category, is now critical because all the categories of population take benefits from it. Consequently, due to low prices, the demand for cereals increased to 195kg/pers./year, mostly composed of bread wheat (bread constitutes 33% of the total) (INS, 2015). For a more qualitative food policy, the question is how to guide consumers in the case of subsided products towards healthy products with regard to the Mediterranean diet (Boudiche *et al*., 2016; Yiannakou *et al.*, 2021).

With regard to products in groups 2 and 3, results show less elastic demand. Especially milk and seed oil prices are fixed in order to encourage their consumption but the price is not only responsible for the increase in their demand due to the influence of other factors such as income.

The income elasticity is lower than 1 for all groups which means that all food products are normal goods. This result is in accordance with the decrease in the food budgetary part (45% in 1990, 38% in 2010 and 26% in 2015). The highest elasticities are observed in group 2 and group 1 which can be explained by red meat, olive oil and fruits where consumption is higher in urban areas and in high income categories.

Table 4 - Estimation of the demand function for groups of food products.

	Group1		Group2		Group3	
Parameters	coefficient	t-student	coefficient	t-student	coefficient	t-student
Constant	-0.89*	1.49	-1.29*	1.94	-3.3**	4.39
Price	-1.26**	15.35	-0.83**	10.4	-0.88**	3.77
Income	0.61**	3.63	0.72**	3.86	0.38**	3.43
Production	0.14**	3.78	0.08	0.27	-0.06**	5.02
Area of habitation	0.62	0.87	0.17	2.17	0.27**	5.11
Quality	-0.015	-0.31	-0.05	-0.89	2.43**	7.13
R-squared	92		86		96	

*Significant at 10%; **Significant at 5%.*

Regarding the production, low values of elasticity production-consumption are observed for the first and the second groups (0.14 and 0.08) and negative values for the third group (-0.06). For the first group, the higher effect of local production could be explained by the influence of cereals, vegetables, legumes, and beef meat on domestic consumption. For the third group, the results indicate that production progress has a negative effect on consumption which could be explained by the saturation of the poultry and eggs demand provided by industrial firms.

Thus, for all groups, we can conclude that production stimulates demand in terms of diversification rather than in terms of the quantities consumed.

The area of habitation effect is observed in groups 2 and 3, indicating differences between urban and rural consumer behavior. Positive and significant signs of parameters for these two groups showed that these products (eggs, poultry, fish, dairy products and fruits) are more consumed in urban areas. In contrast, for the products of group 1, especially basic products, consumption is the same in urban and rural areas which could be explained by the generalization of subsidies for all the population.

The effect of quality is shown only in group 3. This result reveals that the Tunisian consumer is generally unaware of the quality of the consumed products and their relationship with the highly beneficial Mediterranean diet (olive oil and fruits in group 2, durum wheat, legumes and vegetables in group 1). However, for group 3, the consumption of fish and poultry (recommended by the Mediterranean diet in substitution for red meat) is due to the consumers' awareness of their benefits, a fact stimulated by affordable prices.

This research shows that in Tunisia, food consumption has known an important change and has deviated from the Mediterranean diet which used to characterize Tunisian food habits until the 80's. This is in line with data that show a decline in adherence to the Mediterranean food model in all Mediterranean countries (Da Silva *et al*., 2009; Vareiro *et al*., 2009). Due to the social policies based on providing large quantities through price subsidies, high fat and sweet products have been privileged to ensure minimum necessary calories such as seed oil, white bread, wheat and sugar to the detriment of rich fiber products (durum wheat, legumes and vegetables).

While food security policy has strongly contributed to reaching food auto sufficiency in various products (milk, vegetables, poultry and eggs), it has not ensured qualitative security. As social policies are highly based on low prices through subsidies and fixed prices for bread wheat, sugar and seeds oil which became important components of Tunisian food, leading Tunisia to the second world rank in the consumption of bread and pasta (Khaldi *et al*., 2016; INS, 2015). These subsided products responding to high population demand are not in conformity neither with qualitative food security nor with Mediterranean diet. These results are consistent with those proven by Ameur *et al.* (2016) and Souissi *et al*. (2019) who explained the effect of price on increased consumption of subsidized foodstuffs and its consequences in terms of qualitative insecurity (Padilla *et al.*, 2005).

5. Conclusion and policy measures

Food security policy in Tunisia has greatly contributed to the increasing of food availability, but has not helped to ensure quality and healthy food consumption. Considering the negative changes of diet in general, the issue of qualitative food security has become now an imperative in the orientation of the food security policy in Tunisia. Thus, alternative food security policy options, emphasizing qualitative food consumption in conformity with the Mediterranean diet, should enable to provide positive effects in terms of sustainable food consumption. This imperative requires a more appropriate approach with integrated interventions among different levels of the food chain: the producer, the consumer, the public authorities and the local authority.

At the level of policy makers, higher priority should be given by authorities in providing sufficient food quantities to citizens with medium and low income providing at the same time quality food products in order to reduce diseases linked to the distortion of the Mediterranean diet nutrition model. In this respect, it becomes today necessary that the authorities give the priority to guarantee healthy local products with high nutritional value to the population and the young generation. This

could be possible through a better organization and performance of agro food sectors creating efficient links and coordination between all the operators in the value chain, either at the level of institutions (agriculture, industry, health) or at the level of professionals involved in the issue of qualitative food security through a participatory manner. On the other hand, new food policies should opt for less importation of basic products (bread wheat, sugar and oilseeds) reducing the pressure on the state budget due to the high food subsidies and the increased demand of these basic products which have negative effects on human health. Those subsidized basic products generate food waste particularly of bread which receives huge public financial support (40%). Therefore, subsidies should be prioritized and oriented especially to low-income population.

At consumer level, food and nutrition demand policy should focus on higher awareness-raising actions to enhance the consumption of alternative products (olive oil, fish, durum wheat, etc.) and push him towards qualitative food security and Mediterranean diet. This imperative is based on the enhancement of local traditional products and related sustainable production practices with a view to containing this trend and bringing the consumer back to the Mediterranean diet and its sustainable health benefits. In particular, public health institutions and civil society should increase their efforts in raising consumer awareness to reduce the consumption of high-calorie food and the side effects of junk food on health by encouraging nutritional food as recommended by the Mediterranean diet.

The qualitative food security of the population would be ensured by an adequate support for farmers to be engaged in local productions with high added value and for industrialists to produce lower calorie and healthier products. In addition, efforts are required to promote quality local products to consumers, a synergy between institutions and operators and the development of local food value chains.

Farmers should contribute in enhancing a qualitative food security through the promotion of the specific quality and labels in local products especially for small farms (with 1-10 ha) that represent 80% of the total farms in Tunisia. This requires adapted financial support and incentives to pre-serve natural resources and local products with highest added value and then improve their income and in the same time reducing poverty and unemployment in rural areas.

Better governance should be set up towards these farmers, small and medium firms and traders in order to guarantee their viability to supply markets with higher quality products. Also, women and young graduates should be encouraged to contribute to the promotion of qualitative food security through measures and financial programs focusing on start-ups and entrepreneurship especially in rural areas and to produce local products with specific quality (label products, AOC, and organic food among others).

At agricultural research level, it seems necessary to build a scientific knowledge system (agricultural, economic, social, cultural, nutritional, and culinary) and prospective studies on consumption. It is also important to consider innovative plans and training to better communicate information to these farmers. This could be reached through the role of NGOs and agricultural cooperatives.

The work carried out focuses on consumption trends taking into consideration the Mediterranean diet. The results obtained confirm generally the deviation from this model on the basis of the INS five-yearly data. However, it is necessary to deepen the analysis of consumption by direct surveys of consumers (by type of income, region) in order to better understand their perceptions and preferences and the main constraints to the adoption of the Mediterranean diet. A further research on subsidy policy should also be explored with the aim of better targeting low-income populations for quality food. The question is how to support policies that incorporate the characteristics of this model? How can food subsidies target towards the population classes who need them most in order to improve the quality of their food model with more alignment to the Mediterranean diet (e.g. a subsidy for the consumption of olive oil and a price control system for fruit and vegetables). This research provides an opportunity for further studies on food consumption policy reforms and future research in favor of healthy food practices by revising the subsidies policy in order to reallocate subsidies to Mediterranean diet products such as olive oil, durum wheat, legumes and fish to replace highly

subsided products such as seeds oil, sugar, white bread and wheat.

In addition, the issue of qualitative food security is addressed by considering product groups that are close to the Mediterranean model. It is interesting to orient the research towards the quality analysis of the foodstuffs groups (nutritional quality). For this purpose, national surveys should be conducted in order to determine the adherence of the population to the Mediterranean diet allowing the measurement of indexes and scores (Ridolfi *et al.*, 2020; Lacirignola *et al.*, 2015; Souissi *et al*., 2019; FAO, 2016; Visinoni *et al.*, 2017).

Acknowledgments

References

ABD - African Bank of Development, 2013. *Subventions alimentaires et aides sociales directes : Vers un meilleur ciblage de la pauvreté monétaire et des privations en Tunisie*. Available at: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Procurement/Project-related-Procurement/Subventions_alimentaires_et_aides_sociales_directes_-_vers_un_meilleur_ciblage_de_la_pauvret%C3%A9_mon%C3%A9taire_et_des_privations_en_Tunisie.pdf.

ABD - African Bank of Development, 2016. *Production agricole, sécurité alimentaire et ajout de valeur en Afrique du Nord.* Banque africaine de développement, Série sur les notes politiques en Afrique du Nord, 28 pp. Available at: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Afrique_du_Nord_-_Document_de_travail_-_Production_agricole__s%C3%A9curit%C3%A9_alimentaire_et_ajout_de_valeur_en_Afrique_du_Nord.pdf.

Agropolis International, 2011. *Sécurité alimentaire en Méditerranée à l'horizon 2030 : aspects qualitatifs et quantitatifs (SAMAQQ)*. Etude du comité scientifique et technique d'Agropolis International, 68 pp.

Ameur M., Boudiche S., Khaldi R., 2016. Crise économique et volatilité des prix agricoles et agroalimentaires en Tunisie au cours de la période de transition post-révolution. *Watch Letter*, 36, CIHEAM. Available at: https://www.ciheam.org/uploads/attachments/280/WL36.pdf.

Arfaoui M., Boulaares M., Boudiche S., 2021. Competitiveness of Tunisian olive oil exports in a changing world market: A shift share analysis. *European Journal of Economic and Management Science*, 4: 42-52. https://doi.org/10.29013/EJEMS-21-42-52.

Ben Saïd T., Boudiche S., Triki S., 2001. Etude d'impact de l'accord d'association Tunisie-Union européenne pour un secteur stratégique : lait et dérivés. In: Padilla M., Ben Saïd T., Hassainya J., Le Grusse P. (eds.), *Les filières et marchés du lait et dérivés en Méditerranée : état des lieux, problématique et méthodologie pour la recherche*. Montpellier: CIHEAM-IAMM, pp. 88-108 (Options Méditerranéennes: Série B. Etudes et Recherches, n. 32). http://om.ciheam.org/article.php?IDPDF=CI011666.

Boudiche S., Ameur M., Moussi S., Mlaouhi S., 2015. Évaluation de la volatilité des prix des produits agroalimentaires et son impact sur le consommateur en Tunisie. *Journal of New Science of Agriculture and Biotechnologies*, 13: 915-919.

Boudiche S., Ameur M., Rached Z., Khaldi R., 2016. Qualitative or quantitative food security for Tunisia? In: *Book of abstracts du 158ème séminaire de l'Association Européenne des Economistes Agricoles (EAAE)*. « Coopération Euro-méditerranéenne dans l'agriculture durable et la sécurité alimentaire: Politiques, durabilité, marketing et commerce », Institut Agronomique Méditerranéen de Chania – Centre International de Hautes Études Agronomiques Méditerranéennes (IAMCh-CIHEAM), 8-9 Septembre.

CIHEAM, 2012. Vers l'élaboration de recommandations pour améliorer la durabilité de régimes et modes de consommations alimentaires : la diète méditerranéenne comme étude pilote. *Options méditerranéennes, Série B*, 70, 80 pp. http://om.ciheam.org/om/pdf/b70 (fr)/b70 (fr).pdf.

Da Silva R., Bach-Faig A., Raido Quintana B., Buckland G., Vaz de Almeida M.D., Serra-Majem L., 2009. World variation of adherence to the Mediterranean diet, in 1961-1965 and 2000-2003. *Public Health Nutrition*, 12(9A): 1676-1684.

Dernini S., Berry E., Bach-Faig A., Belahsen R., Donini L., Lairon D., Serra-Majem L, Cannella C., 2012. Un modèle alimentaire construit par les scientifiques. In: *La diète méditerranéenne pour un développement régional durable*, Mediterra 2012, CIHEAM. Paris: Presses de Sciences Po.

Dogui D., Doggui R., El Ati J., El Ati-Hellal M., 2021. *Association between Overweight and Diet Diversity Score: A Cross-Sectional Study Conducted among Tunisian Children*, Children, 8(7): 536. https://doi.org/10.3390/children8070536.

El Ati J., Traissac P., Delpeuch F., Aounallah-Skhiri H., Béji C. *et al.*, 2012. Gender Obesity Inequities Are Huge but Differ Greatly According to Environment and Socio-Economics in a North African Setting: A National Cross-Sectional Study in Tunisia. *Plos One*, 7(10): e48153. DOI: 10.1371/journal.pone.0048153.

FAO, 1996. *Rome Declaration on World Food Security*. World Food Summit, 13-17 of November 1996, Rome, Italy. Available at: http://www.fao.org/wfs/index_en.htm (accessed from FAO Corporate Document Repository, 13 January 2015).

FAO, 2014. *State of Food and Agriculture in the Near East and North Africa Region*. Rome: FAO.

FAO, 2016. *Food security indicators*. http://www.fao.org/economics/ess/ess-fs/ess-faodata.

INS - Institut National de la Statistique, 2015. *Enquête Nationale sur le Budget, Consommation et le Niveau de vie des ménages. Tunisie*, vol. A, Ministère du Développement et de la Coopération Internationale.

INS - Institut National de la Statistique, 2017. *Enquête Nationale sur le Budget, Consommation et le Niveau de vie des ménages*.

Karray B., 1996. Consommation des huiles et corps gras en Tunisie. *Ezzaitouna*, 2(1-2): 65-78.

Karray B., 2012. Enjeux de la filière oléicole en Tunisie et axes de développement dans le nouveau contexte politique. *Notes d'analyse du CIHEAM*, 66. Available at: https://www.iamm.ciheam.org/ress_doc/opac_css/doc_num.php?explnum_id=9078.

Khaldi R., Boudiche S., Ameur M., Rached Z., Sfayhi D., 2016. Renaissance de la diète méditerranéenne en Tunisie pour une alimentation durable à travers une approche territoriale intégrée. In: *Proceedings of 1st AMSR Congress* (Association marocaine des sciences régionales) *and 23rd APDR Congress* (Associação Portuguesa Para o desenvolvimiento regional) *on 'Sustainability of Territories in the Context of Global Changes'* (Marrakech, Morroco, 30-31 May), pp. 272-281.

Khaldi R., Dhehibi B., Rached Z., 2007. Dynamic demand analysis for tomatoes in Tunisia. *Acta Horticulturae*, 758: 145-152 DOI: 10.17660/ActaHortic.2007.758.15.

Khaldi R., Dhehibi B., Rached Z., Dharief M.Z., 2009. La consommation de la pomme de terre et des légumes frais en Tunisie : un diagnostic contrasté et des effets prix et dépenses alimentaires différenciés par milieu d'habitat. *New Medit*, 8(2): 14-22.

Khaldi R., Naïli A., 1995. Analyse des politiques de la sécurité alimentaire en Tunisie. In: Padilla M., Le Bihan G. (eds.), La sécurité alimentaire en Méditerranée, *Options Méditerranéennes,* Série A, 26: 91-109.

Khaldi R., Saadia B., 2017. *Analyse de la filière céréalière en Tunisie et identification des principaux points de dysfonctionnement à l'origine des pertes*, FAO. Available at: http://www.onagri.nat.tn/uploads/Etudes/RapportIVF.pdf.

Lacirignola C., Capitanio F., Adinolfi F., 2015. Food security in the Mediterranean countries. *New Medit*, 14(4): 2-10.

Lacirignola C., Capone R., 2009. Mediterranean Diet: Territorial Identity and food safety. *New Medit*, 8(4): 2-3.

Malassis L., Allaya M., 1996. Equilibrio alimentare. In: *Introduzione all'economia agroalimentare*. Bologna: Il Mulino, pp. 191-290.

MedDiet, 2017. *The history, the basics and the benefits of the Mediterranean Diet*. Publication of the Projet EU - ENPI CBC Med: MedDiet - Mediterranean Diet and Enhancement of Traditional Foodstuff, 50 pp. www.med-diet.eu.

Ministry of Health - Ministère de la Santé, 2019. *La santé des Tunisiens : résultats de l'enquête "Tunisian Health Examination Survey-2016"*.

MRAH - Ministry of Agriculture, Hydraulic Resources and Fishery, several years. *Annuaire des statistiques agricoles*, Direction générale des études et de développement agricole.

NOAT - National Observatory of Agriculture of Tunisia, 2020. *Indicateurs clés des filières agricoles en Tunisie*.

Padilla M., Ahmed Z.S., Wassef H., 2005. En Méditerranée : Sécurité alimentaire quantitative mais insécurité qualitative. *Notes d'analyse du CIHEAM*, 4, 19 pp.

Rastoin J.L., Ghersi G., 2010. *Le système alimentaire mondial. Concepts et méthodes, analyses et dynamiques*. Versailles: Editions Quae, 584 pp.

Ridolfi R., Dernini S., Morrison J., Mathiesen Á.M., Capone R., 2020. Changing Route: Common Action on Food Systems Transformation in the Mediterranean. *New Medit*, 19(3): 119-128. https://doi.org/10.30682/nm2003h2.

Souissi A., Mtimet N., Thabet Ch., Stambouli T., Chebil A., 2019. Impact of food consumption on water footprint and food security in Tunisia. *Food security*, 11(5): 989-1008.

UNESCO, 2010. *Inscription of Mediterranean diet on the Representative List of the Intangible Cultural Heritage of Humanity*. Intergovernmental Committee for the Safeguarding of the Intangible Cultural Heritage. https://mediterraneandietunesco.org/about/unesco-nomination/.

Vareiro D., Bach-Faig A., Raidó Quintana B., Bertomeu I., Buckland G., Vaz de Almeida M.D., Serra-Majem L., 2009. Availability of Mediterranean and non-Mediterranean foods during the last four decades: comparison of several geographical areas. *Public Health Nutrition*, 12(9A): 1667-1675.

Visinoni C., Redaelli L., Tidone C., Garlaschelli K., Grigore l., Baragetti A., Norata G.D., Catapano A.L., 2017. The PREDIMED Score: Index of ad-

herence to the Mediterranean diet in the general population: The PLIC study. *Atherosclerosis*, 263: E92. https://doi.org/10.1016/j.atherosclerosis.2017.06.299.

Yiannakou I., Singer M.R., Jacques P.F., Xanthakis V., Ellison R.C., Moore L.L., 2021. Adherence to a Mediterranean-Style Dietary Pattern and Cancer Risk in a Prospective Cohort Study. *Nutrients*, 13(11): 4064. https://doi.org/10.3390/nu13114064.

Annex 1 - Anova results: Comparison of rural and urban foodstuffs consumption

Foodstuffs	Anova with quantities consumed		Anova with consumption evolution rate (CER)	
	F	*Signification*	*F*	*Signification*
Durum wheat	96,063	,000	,503	,495
Bread Wheat	69,078	,000	7,925	,018
Legumes	2,249	,160	3,498	,091
Fresh vegetables	29,011	,000	1,651	,228
Fruits	3,289	,095	1,804	,209
Sheepmeat	19,884	,001	1,530	,244
Beefmeat	48,055	,000	,000	,990
Poultry	2,426	,145	,496	,497
Fish	59,109	,000	6,351	,030
Milk products	33,411	,000	,122	,734
Eggs	8,729	,747	4,598	,058
Olive oil	1,670	,712	19,976	,001
Seedoil	,142	,738	9,635	,011
Sugar	,117	,003	2,266	,163

Source: Our calculation from SPSS.

Annex 2 - Results of clustering of food staffs

Product	Means	Std Deviation	Clusters
Durum wheat	-0.140	0.107	1
Bread wheat	0.085	0.317	1
Legumes	-0.10	0.131	1
Fresh vegetables	0.161	0.075	1
Sugar	0.149	0.065	1
Beef meat	-0.292	0.210	1
Milk products	0.198	0.442	2
Fruits	0.445	0.456	2
Olive oil	0.577	0.407	2
Seed oil	0.468	0.157	2
Sheep meat	0.621	0.243	2
Poultry	0.636	0.710	3
Fish	0.531	0.709	3
Eggs	0.776	0.824	3

Source: Our calculation from SPSS.