

Mapping foodscapes for dietary change to promote sustainable diets in rural farming communities in Tunisia



INITIATIVE ON
Agroecology

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Contents

Executive summary	4
Background	5
Methodology	7
Participant recruitment	10
Focus group procedures.....	10
Focus group discussions' data analysis.....	11
Community walk route selection	12
Community resources/facilities information.....	12
Food cost data collection.....	12
Food cost data analysis	13
Results	14
Cost of food in the market	15
Food purchasing environment.....	18
Market observation routes.....	21
Packaged snacks assessment	27
Restaurant assessment	28
Observations in grocery stores	34
Focus group findings	35
Participants	35
Findings from focus group discussions.....	36
Discussion	50
Recommendations	55
References	57
Annex	61

Executive Summary

Tunisia, a country with Mediterranean climate in the north and semiarid climate in the south, is facing the triple burden of nutrition with a high rate of obesity, micronutrient deficiencies and reduced yet still existing malnutrition.

Threatened by climate change, food systems including production, processing, consumption and trade require changes to support sustainable diets. This study presents an assessment of the foodscapes as experienced by consumers and producers in rural communities in Tunisia.

These foodscapes were assessed by examining food markets for availability of food and cost of diets; brief review of restaurants and grocery stores in highly visited community areas, and by gaining insights into the food beliefs and perspectives of farmers in selected communities. Focus group discussions with 39 individuals who were members of the local farming cooperatives in Gaafour, Kesra, Makthar and Sers in the governorates of El Kef and Siliana were conducted. The markets were surveyed by listing the availability and price of food from the Diet Quality Questionnaire, a rapid dietary quality assessment tool validated for Tunisia by 2022, with few additional food items to get the cost of food for consumers in the areas selected. Availability of paved roads, public transportation and public services were also considered in assessing the foodscapes as these influence ease of access to food.

Focus group discussions provided insight into the food beliefs of the participants. These food beliefs indicated high regard for grain-based and animal products-based held by the participants. Food cultures appeared to be influenced by the availability of products and religious festivities and occasions like Ramadan. Women were almost always in charge of food preparation while men almost exclusively managed the food budget and were the main household members shopping for food. The cost of food fluctuated among the communities surveyed depending on the availability of foods priced out. Majority of food ads were promoting unhealthy food choices including display of unhealthy products. Restaurant and street food vendors sold high calorie products with majority based on wheat and sugar. Multi-faceted interventions are needed to counteract the rising rates of obesity in Tunisia. School-based interventions may be effective in promoting good nutrition, however, the external food environment will need to change to increase the availability of healthy food options in the markets, restaurants, food cart vendors and convenience stores. Anecdotal information about the negative impact of social media and broadcast media on diets are venues that can be utilized to strengthen the promotion of sustainable diets to different age groups in Tunisia.

Background

With the ever-increasing rates of malnutrition, both overnutrition and undernutrition, improving agricultural and consumption practices globally plays a critical role in supporting sustainable diets. Sustainable diets have been defined as “*diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations [and which are] protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources*” (Pimbert & Lemke, 2018). To discover appropriate opportunities to support sustainable diets, the foodscape of the target areas and populations should be studied. The term foodscape has been approached from any of the four broad perspectives namely spatial, sociocultural, behavioural and systemic (Vonthron et al., 2020). A foodscape assessment entails not only looking at the community food environment, the spatial approach, but also at the food experiences of the targeted population, the socio-cultural approach. For the purposes of the current study, the foodscape of select rural communities in Tunisia, where agroecological interventions are planned to be initiated, was studied taking a spatial and sociocultural approach. The elements of foodscapes studies as per Turner et al. (2018) include: availability, diversity, accessibility, prices and affordability, vendor and product properties and convenience, marketing, promotion, quality, and regulation. These components are considered in the present study in Tunisia whose population faces nutrition-related adverse conditions.

The sustainability of the Tunisian's diets is challenged from not only an environmental perspective with high consumption of foods of animal origin with unequal distribution throughout the country (Perignon, 2019), but also from a nutritional perspective. Indeed, overnutrition in Tunisia has risen to a higher rate, 37.2% among women aged 18 years and over, than that of undernutrition with 8.4% of children under 5 years stunted and 2.1% suffering from wasting (Global Nutrition Report, 2021). Micronutrient deficiencies such as vitamins A, D and iron deficiency anemia (Doggui et al, 2020; Salem et al, 2021) indicate poor quality diets with possibly low nutrient density. Of the nutrition strategies' indicators listed for Tunisia, no food-based dietary guidelines have been implemented. Adult females overall have a higher rate of both underweight and overweight and obesity compared to their male counterparts (Global Nutrition Report, 2021), which indicate gender imbalance in nutritional status with women being more adversely affected than their male counterparts. Whether the same nutritional status indicators prevail among rural farmers, is not known.

Recent evidence has pointed to positive effect of majority of agroecological interventions on food security and nutrition (Kerr et al., 2021). The interventions have looked into dietary diversity as an indicator of adequate nutrients in the diet of participants. However, the commonly used measures of dietary diversity,

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Minimum Dietary Diversity for Women (FAO & FHI, 2016) has focused on adequacy of nutrients rather than taking into account the consumption of foods high in calories and low in nutrients whose consumption should be limited. This is particularly important in the face of increasing rates of obesity. A simplified dietary quality questionnaire (DQQ) developed and validated for Tunisia (Gallup et al., 2022 & Uyar et al., 2023) was released in 2022 for use as a tool in assessing the dietary quality of Tunisians with other adaptations for other countries. The promotion of sustainable diets requires information about the factors that influence food-related decision making. Thus, observing the foodscape elements like food prices, which has witnessed a 12.9% rise over a year in October 2022 followed by a steep 13% increase in one month alone in November 2022 in Tunisia (Trading Economics, n.d.), is critical.

Thus the present study of foodscapes in rural Tunisia is multi-component including a market survey including both environmental survey of available foods and their prices in the market, restaurants review, snack foods assessment, availability of various facilities and resources in the communities such as schools, hospitals and paved roads and the voice of research participants related to food behaviour beliefs and perspectives on nutrition. The participatory nature of developing a food behaviour intervention that is effective and acceptable to partners is, thus, integrated from the initial stage of foodscape assessment and shall continue in future stages of potential food, nutrition and agroecological interventions.

The purpose of this study is to present the foodscape of rural farming household communities in Tunisia. This understanding shall help guide the design of food behaviour change interventions to facilitate the adoption of sustainable nutritious diets.

Objectives:

1. To determine the cost of nutritionally balanced diets based on local availability of foods utilized in rural Tunisia;
2. To describe the physical food environment related to the availability of food outlets, markets, transportation, and other relevant resources in the targeted communities;
3. To determine the factors influencing the food behaviour of the targeted community members as perceived by them; and
4. To locate the most promising health promoting food practices with high potential to be achievable and that promote dietary sustainability in the context of the rural farming communities in Tunisia.

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Methodology

Community selection for this study was based on the planned agroecological interventions that are to take place in the same communities in northern and northwest Tunisian governorates of Siliana and El-Kef. The communities in Siliana were Gaafour, Makthar and Kesra while one community in El-Kef was Sers.

The following tools were utilized to collect relevant data for this study:

Table 1. Data collection tools and their use to meet the objectives of the study

Tools	Parameters covered by the tool	Remarks
- Environmental Profile of a Community's Health (EPOCH) (Chow et al., 2010)	<ul style="list-style-type: none"> - Provides listing of facilities available in the community such as schools, medical services, grocery stores, paved roads, public transportation - Community walk survey allows for collection of data regarding food advertisement, type of food outlets including type of food sold by street food vendors, quality of sidewalks and existence of green spaces such as trees and flower beds. - Includes restaurant assessment and snack assessment components 	The EPOCH design by itself provides a static cross-sectional view of how things stand at one point in time. Changes over time cannot be measured using this tool alone and once. Also, the restaurant and grocery store assessment is not representative of all the restaurants and grocery stores or informal food acquisition activities that occur in rural communities. Nonetheless, it provides an opportunity to collect expansive data on food and health related components in both rural and urban communities. The tobacco use related sections of the survey was omitted for the purposes of this study.
- Food costing based on Diet Quality Questionnaire (DQQ) (Gallup et al., n.d.)	<ul style="list-style-type: none"> - Determines the availability of foods common to Tunisians' diets in the markets visited. - The food groups included in the survey include both healthy and less healthy options grouped separately. This allows for comparison of the cost of particular groups such as white 	Since the DQQ is for use in all seasons, some of the seasonal items and those cooked commonly in household settings would not be available for costing in the market. Also, the cost of some commonly used items like herbs and spices

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	grains vs. whole grains and legumes vs. red meat vs. white meat products.	common in Tunisian diets is not included in DQQ.
<p>Focus Groups</p> <p>A semi-structured focus group discussion guide was utilized for all focus groups. See Table 2.</p>	<p>Obtaining participants' perspectives on:</p> <ul style="list-style-type: none"> - factors that influence their food behaviour - how their food behaviour can be modified - what foods are part of a healthy diet - what their needs to help them adopt healthy diets 	<p>The shortcomings of focus groups are:</p> <ul style="list-style-type: none"> - Not all participants are vocal in sharing their perspectives - The focus group participants may not represent all the communities' population and their perspectives - participants may not remember to share some points that they may remember later or feel shy to share some contrasting perspectives - social desirability bias may influence the responses given

Table 2. Focus group discussion guiding questions

No.	Questions	Objective of the question	Note to facilitators
1	<p>How can people in _____ (name of community) eat healthy food?</p> <p>Probes: What resources in this community help people eat healthy foods and what things discourage or disable this?</p>	<i>Explore barriers and facilitators to healthy eating and beliefs on what constitutes healthy foods.</i>	Ask participants to start building the map by placing the resources that facilitate (green color marker) and prevent (red color marker) people from eating healthily. List the foods that the participants list as healthy on a poster paper on the side of the map (3 large poster papers on the board)
2	Are these foods easy to grow without causing damage to the environment?	<i>Explore knowledge, beliefs, attitudes to sustainable food production and</i>	Ask participants to point out the foods on the list of healthy foods that they

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		<i>consumption; what are the perceived barriers & facilitators</i>	perceive as sustainable. Highlight them.
3	(If legumes are not mentioned as sustainable foods, ask this question): Let's look at legumes as a substitute for meat in meals. What do you think about this?	<i>Gather positive and negative opinions about plant-based proteins' topic; find facilitators/barriers to legume consumption to replace animal protein</i>	
4	Do families eat differently now (your own families with your children) compared to a generation earlier (when you were children)?	Ask about processed food and what participants think about them (do they prefer particular brands)	<i>Make a parallel map on to the left of the resource map and ask participants how they compare changes that impacted food behaviours over whatever time span they choose to talk about</i>
5	How can people be convinced to change what they normally eat? Or what can help people eat more healthy sustainable foods? Probes: - What resources/support can help people eat more healthy and sustainable foods? – How can barriers to this be removed or minimized?	<i>Explore influencers: knowledge, cultural practices, taste, peers/community members, collective food related activities like festivities and social gatherings</i> <i>Explore options like kitchen gardens and relevant factors encouraging and/or discouraging kitchen gardening</i>	Mark if any changes in technology/life style/urbanization/etc have impacted diets along the historical timeline on the map.
6	Have the varieties of available vegetables and fruits or other foods changed over time in your community? Are there varieties or foods that are no longer eaten or eaten seldom compared to old times?	Explore the role of collecting wild plants and informal markets and changes in these practices along the historical timeline. Elicit perceptions of participants about this practice.	Note the changes/events on the timeline map

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	Probes: What changes caused this?		
7	<p>How does your faith/religion affect your food habits?</p> <p>- If participants do not mention not wasting food, ask: What about food waste? Do people follow religious teachings about food consumption/waste?</p>		
8	Thank participants and ask if anyone would like to add anything to the answers or to the discussion.		

Participant recruitment

In each of the four communities where agroecological interventions are to be implemented, a farmer organization exists. These farmer organizations were requested to inform their members about the focus groups. The members, who responded to the call, were provided with information about the date and venue for focus group discussions and the purpose of the discussion. The target was to get 10 participants for each of the focus groups so 12 members who showed interest and were available at the time of the call were invited.

Focus group procedures

Participants filled out a brief demographics' questionnaire (see Box 1) as they came to the assigned location for the focus group discussion in each of the communities. They were asked about their height and weight as a proxy of their level of awareness of their health in relation to their body weight. Then they were asked if they would like to have their height and weight measured. Height and weight were measured using a flexible measuring tape mounted on a wall or a nearby upright structure. Participants were asked to remove their shoes to get their height measurement. The scale was placed beside the measuring tape on the ground so participants could get onto the scale without having to take their shoes off twice. A digital scale for use in households was considered appropriate, as this was not a clinical study requiring precise measurements. Due to cold temperature in the room and outdoors, participants had to keep their jackets and have thick clothing, which was estimated at two kilograms and was deducted from their weight. The questionnaire that was filled out is shown below. Each participant was given a number from one to eleven in order. The purpose was to

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help extract quotations from various participants and identify if there were any trends in beliefs regarding variables like education, gender, and age. Focus groups were audio recorded unless permission was not granted by any participant. Only in one of the focus groups, one participant did not agree to the audio recording. So one research assistant was assigned to take detailed notes and no audio recording took place. All audio recordings were translated and the translations typed within one to 3 days following the focus group discussions.

Focus group discussions' data analysis

Inductive and deductive coding (Saldana, 2009) was used for thematic content analysis (Saldana, 2009) using the overarching pre-determined themes of food beliefs of participants; factors the participants perceived that influenced their dietary practices, and their perception of food sustainability. The concept of

Box 1. Focus Group Demographics Questionnaire for Participants in _____ (community name)

Full Name: _____ (assign a number _____)

Age	
Education	
Occupation	
Marital Status	Married Single Divorced/widowed
Number of children	
Total number of household members	
Who is in charge of managing the meals and kitchen in your household	
Who is in charge of food budget in your household	
Who is in charge of grocery shopping in your household	
Your weight (kg)	_____ (reported) _____ (actual)
Your height (cm)	_____ (reported) _____ (actual)

legumes as meat alternatives was explored as well the effect of religious beliefs or customs on dietary practices. Opportunity was given to participants to share

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any information relevant to the topic during the discussion as well as at the end of the focus group. Relevant quotes from participants both male and female were included in clarifying any of the points made. Effort was put into using in-vivo coding (Saldana, 2009) when possible without losing clarity in presenting the themes.

Community walk route selection

The EPOCH survey specifies selecting a point in the community where there is a relatively high concentration of people. We selected the fresh market area starting from any street by the fresh market and walked through the longest stretch of the market stands. The recommended distance to be covered one way as per EPOCH is 300 to 500 meters amounting to 600 to 1000 meters covering both sides of the selected path or road. Marketplace was determined to be the busiest place in the community.

Community resources/facilities information

Information about transportation, schools, factories, government offices and other information about the communities was attained from research team members local to or in close contact with the communities surveyed. One of the research assistants was a resident of one of the communities, which was helpful in obtaining critical information about the markets and facilities in the particular community as well as other communities in the same province of Siliana as well as in the neighbouring community of Sers.

To determine the nutritional status of the focus group participants, their height and weight was measured to calculate their body mass index as a proxy indicator of their nutritional status (WHO-Europe, 2010). BMI categories use to classify the BMIs of the participants were: underweight= 18.5 kg/m^2 , normal weight= $18.5\text{-}24.9 \text{ kg/m}^2$, pre-obesity= $25\text{-}29.9 \text{ kg/m}^2$ and obese (including all classes)= $30\text{+} \text{ kg/m}^2$ (WHO-Europe, 2010). In determining nutritionally acceptable food intake, the following macronutrient ranges were targeted: carbohydrates (45-65% of energy), protein (10-35% of energy), and fat (20-35% of energy) (Manore, 2005). For micronutrient adequacy a minimum of food intake from five food groups as per Minimum Dietary Diversity (FAO & FHI, 2016) as well as the inclusion of 400g of fruits and vegetables for their cardioprotective properties was targeted (WHO-Europe, 2010). Regarding caloric adequacy an average of 2000 and 2500 calories per day for women and men (Strid et al., 2021; Sommersten et al., 2022), respectively, was considered. Furthermore, the inclusion of normally available locally produced food accommodating food beliefs and cultural dietary practices were considered important.

Food cost data collection

For community assessment part of the study, the data will be presented descriptively. The facilities that are included in the survey are indicators of

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walkability and physical access to food outlets as well as qualitative assessment of promotional items or advertisement related to food.

Food cost data analysis

The price of similar food items from the DQQ survey was grouped and the average price calculated. These “price groups” include: 1) white grains, 2) whole grains, 3) vegetables, 4) fruits, 5) Eggs, 6) Dairy products, 7) red meat and chicken, 8) fish, 9) nuts and seeds, 10) processed snacks like cookies, 11) legumes, 12) oil, 13) sugar drinks, 14) deli meats. Candies and fast foods were also group separately but not used in the calculation of the hypothetical diet cost. The serving sizes were determined using the United States Department of Agriculture food database and the nutrient database for Tunisia (2010) since these are available online. Macronutrient content of the foods was also noted and the average macronutrient for each group was calculated. If a food item was not found in a community, it was left blank. If a serving size was not found in the database, it was estimated based on the major macronutrient content of the foods in the same group.

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Results

Four communities in two provinces of Siliana (numbers 1, 3 and 4) and El-Kef (number 2) were surveyed: 1) Gaafour, 2) Sers, 3) Makthar, 4) Kesra on January 9, 11, 12 and 13 respectively.

Table 3. Description of the surveyed communities' structural and service-related arrangement

Community	Connectivity	Facilities that exist	Facilities that do NOT exist
Gaafour Postal Code: 6110 Arrangement of community: Centered	Regular transport hourly or 2 or more times per hour	1. Supermarket (small) 2. General store/convenience stores 3. Market store (e.g. bakery, butcher, fruit market) 4. Restaurant/café/fast-food outlet 5. Take out store/street store/coffee or food cart/food stand 6. Primary or secondary school 7. Post office 8. Police station 9. Government building accessible to community 10. Public park/recreational area/gardens 11. Paved roads 12. Electrical street lighting 13. Internet access enabled 14. Connected to a highway 15. Public medical clinic 16. Public hospital 17. Pharmacy	1. Vending machines for snacks or drinks 2. College/university/post-secondary Technical college 3. Traffic lights 4. Factory
Sers Postal code: 7180 Arrangement of community: Centered	Regular transport services available (train and bus daily; mini-bus or shared taxi hourly (10 to 19 times a day))	1. Supermarket 2. General/convenience store 3. Market store (butcher, bakery, fruit market, etc) 4. Restaurant/café/fast-food sit-down restaurant 5. Take out store/street store/coffee or food cart/food stand 6. Primary or secondary school 7. Post office 8. Police station 9. Paved roads 10. Electrical street lighting 11. Internet access enabled 12. Factory (used clothes depot and forage processing) 13. Connected to a highway 14. Public hospital 15. Pharmacy	1. Vending machines for snacks or drinks 2. College/university/post-secondary Technical college 3. Traffic lights
Makthar	Regular transport services	1. Supermarket 2. General/convenience store	1. Train 2. Vending machines for snacks or drinks

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Postal code: 6140 Arrangement of community: Non- centered (in recent years there are 2 centres in the area)	available (bus daily; mini-bus or shared taxi 5-9 times daily.	3. Market store (butcher, bakery, fruit market, etc) 4. Restaurant/café/fast-food sit-down restaurant 5. Take out store/street store/coffee or food cart/food stand 6. Primary or secondary school 7. Post office 8. Police station 9. Library 10. Paved roads 11. Connected to a highway 12. Public hospital 13. Private medical clinic 14. Pharmacy	3. College/university/post- secondary Technical college 4. Traffic lights 5. Factory
Kesra Postal code: 6114 Arrangement of community: Centered (centre name: Kesra Jdida meaning New Kesra)	Regular transport services available (bus daily; mini-bus or shared taxi 5-9 times daily.	1. General/convenience store 2. Market store (butcher, bakery, fruit market, etc) 3. Restaurant/café/fast-food sit-down restaurant 4. Take out store/street store/coffee or food cart/food stand 5. Primary or secondary school 6. Post office 7. Police station 8. Government building accessible to community (e.g. community centre) 9. Public park 10. Mostly paved roads 11. Connected to a highway 12. Electrical street lighting 13. Internet access enabled 14. Public medical clinic 15. Pharmacy	1. Train 2. Supermarket 3. Vending machine for drinks or snacks 4. College/university/post- secondary technical college 5. Traffic lights 6. Factory 7. Public hospital

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Cost of Food in the Market

The food items selected for costing were extracted from the Diet Quality Questionnaire (DQQ) developed for Tunisia. Thus it contains items normally consumed and found in Tunisia. To determine the cost of a nutritious diet, average cost of foods contained in the DQQ was used. Serving sizes and nutrient analysis was adopted from United States Department of Agriculture's Food Data Central database and the Tunisian food's Table of Food Compositions (2007) was used as the main sources for food composition analysis. Only macronutrients were considered in assessing the adequacy of the selected foods and the final cost of a hypothetical daily food intake. Acceptable distribution range for the macronutrients are 45%-65% of energy from carbohydrate, 10%-35% of energy from protein, and 20%-35% of energy from fat with generally acceptable caloric intake of 2000 and 2500 kcal for women and men, respectively. The constructed diet (in Table 4) meets the minimum vegetables and fruits quantity as per WHO's recommendation and the minimum dietary diversity within the caloric amounts considered adequate on average for men and women.

Table 4. Average cost of food across surveyed communities for a balanced healthy diet catering to the accustomed food types of Tunisians as per DQQ

Men	Average calories (kcal)	Average CHO (g)	Average protein (g)	Average fat (g)	Average price (Tunisian Dinars)
White grains x1 portion	179	37	6	1	0.08
Whole grains x4 portion	737	150	22	6	1.03
Potatoes x1	47	10.39	1	0.05	0.09
Legumes x2 portions	375	60	26	3	1.22
Vegetables x3	109	21	5	1	0.54
Fruits x2	166	35	2	1	1.34
Eggs 2x1	143	1	12	10	0.78
Dairy productsx1	152	12	8	8	1.36
Meat/fish/poultry x1	184	2	22	10	2.25
Nuts half serving	82	1	3	7	0.57
Oil x2.5 tbsp	338	0	0	38	0.40
Total	2512	329	107	84	9.66
% of calories from Macronutrients		52%	17%	30%	

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Women	Average calories (kcal)	Average CHO (g)	Average protein (g)	Average fat (g)	Average price (Tunisian Dinars)
White grains x1 portion	179	37	6	1	0.08
Whole grains x4	695	143	21	6	1.03
Legumes x1	187	30	13	2	0.51
Vegetables x3	89	16	5	1	0.54
Fruits x2	166	35	2	1	1.34
Eggs 1	72	0	6	5	0.39
Dairyx1	152	12	8	8	1.36
Meat/fish/poultry x1	184	2	22	10	2.25
Nuts half serving	82	1	3	7	0.57
Oil x1.5 tbsp	203	0	0	23	0.30
Total	2009	276	85	63	8.37
% of calories from Macronutrients		55%	17%	28%	

The average macronutrients were not the same across the four communities. The cost of the constructed daily diet was different across the surveyed communities. It ranged from 8.78 Tunisian Dinars in Gaafour to 10.39 in Makthar for men and 8.12 Tunisian Dinars in Gaafour to 9.53 in Makthar for women. This is depicted in the table 5 below. The higher price in Makthar could be due to the fact that the survey was not conducted in the weekly market setting but rather in a stationery closed market. For a less costly diet, nuts and red meat can be replaced by fish, chicken, and legumes. Within nuts, peanuts as a cheap option can be easily incorporated in the diet reducing its cost. However, focus group discussions show that participants not only like eating red meat, but also believe it is healthy. Average price of white grain products were 0.09 while that of whole grains was 0.26 per portion across the four communities surveyed.

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Table 5. Cost of healthy and culturally compatible diet for men and women in four rural communities in Tunisia

Men	Sers-Average price	Makthar-Average price	Kesra-Average Price	Gaafour-Average price	Comments
White grains x1 portion	0.06	0.10	0.06	0.11	Higher price is due to rice
Whole grains x4 portion	1.24	0.95	0.86	1.06	
Potatoes x1	0.10	0.09	0.11	0.07	
Legumes x2.5 portions	1.17	1.17	1.68	0.88	
Vegetables x3	0.49	0.50	0.56	0.60	
Fruits x2	1.29	1.79	1.12	1.17	
Eggs 2x1	0.86	0.75	0.75	0.38	
Dairy products x1	1.07	1.68	1.68	0.99	Higher price due to cheese
Meat, Fish, Poultry x1	2.09	2.19	2.13	2.57	
Nuts half serving	0.35	0.79	0.60	0.52	
Oil x2.5 tbsp	0.39	0.37	0.39	0.44	
Total	9.11	10.39	9.95	8.78	

Women	Sers-Average price	Makthar-Average price	Kesra-Average Price	Gaafour-Average price
White grains x1 portion	0.06	0.10	0.06	0.11
Whole grains x4	1.24	0.95	0.86	1.06
Legumes x1	0.47	0.47	0.67	0.44
Veg x3	0.49	0.50	0.56	0.60
Fruits x2	1.29	1.79	1.12	1.17
Eggs 1 x1	0.43	0.38	0.38	0.38
Dairyx1	1.07	1.68	1.68	0.99
MFPx1	2.09	2.19	2.13	2.57
Nuts half serving	0.35	0.79	0.60	0.52
Oil x2 tbsp	0.31	0.30	0.32	0.29
Total	7.81	9.15	8.38	8.12

Food Purchasing Environment

The bulk of food purchasing for a household appears to occur on fresh market days in all the communities surveyed. The fresh food market takes place once a week. In Makthar there is a smaller open area in the centre where fruits and vegetables are sold on a daily basis. From the items listed in the household food

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survey (DQQ), fruits and vegetables as well as legumes are generally available in the fresh market. Grain products such as bread, couscous, dairy products, eggs, fish and meat products are available in butcher and bakery stores with dairy products in general stores that exist in all the communities. All the communities visited, except Kesra, had a grocery store with small selection of fresh vegetables and fruits. The fresh market observation data including cost of food and food and drinks' advertisements, restaurants and grocery store observations are presented in Table 6 below.

Table 6. Geographic location of the market observations and availability of food-consumer interaction points

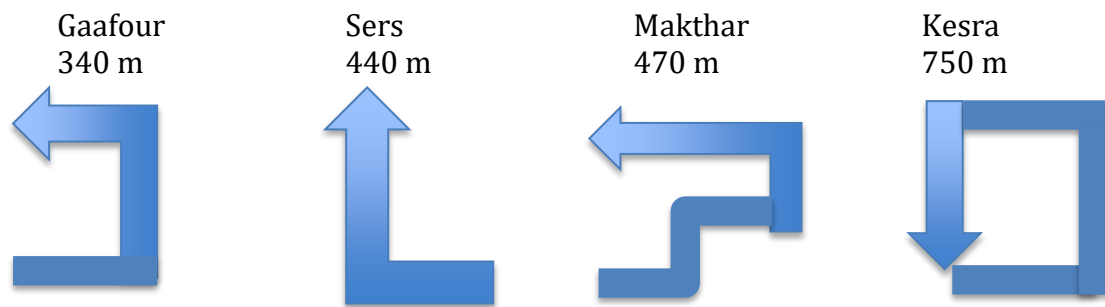
Area	Distance covered	GPS coordinates	A) Sidewalk quality & B) public places	Stores/stands in the market place	Food and nutritional health related advertisements
Gaafou r	340 m (one way); 680 m (both sides of the road)	Start point (36.322655 2; 9.3227163), End point (36.320855 7; 9.3231887)	A) - Partial sidewalk; - Main road is used for walking on market days; - Quality rating 2 out of 4 with 4 being well-maintained and 1 poorly maintained B) - For recreation/physical activity: 1 open-air theatre - Street trees/street flower beds: 10	A. Fresh fruits and vegetables' open space weekly market B. Convenience stores: 5 C. Vendors/street stands/snack food shops: 5 D. (1 biscuits, 2 popcorn and 2 candied peanuts food carts. E. Butcher/meat store (includes 1 deli meat store): 3	A) Food/snack food: 5 (4 healthy and 1 high calorie low nutrient density choices) B) Sugar drinks: 7
Sers	440 m (one way) 880m (both sides of the road)	Start point (36.074481 8; 9.0211377) End-point (Aziza store: 36.0746589; 9.0245409)	A) - Partial sidewalk; - Main road is used for walking on market days; - Quality rating 2	A. Fresh fruits and vegetables' open space weekly market B. Convenience stores: 5 C. Vendors/street stands/snack food shops: 4 (biscuits x2, pastries, salted peanuts)	A) Food/sna ck foods: 11 (10 low nutrient density foods) B) Sugary drinks: 5

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			B) 29 trees	D. Bakery: 1 E. Specialty food store: 2 F. Cafes/fast casual restaurants: 2	
Makthar	470 m (one way) 940 m (both sides of the road)	Start point (35.8586977; 9.2014211) End-point (35.8583074; 9.2027669)	A) - Partial sidewalk; - Main road is used for walking on market days; - Quality rating 2 B) 16 trees and 1 centre old tower surrounded by small flower beds	A. Fresh fruits and vegetables' open space weekly market B. Convenience stores: 6 C. Bakery: 1 D. Butcher/meat store: 15 E. Specialty store: 1 (spices, legumes and nuts) F. Cafes/fast casual restaurants: 5	A) Food/snack foods: 6 (3 low nutrient density foods) B) Sugary drinks: 3
Kesra (centre name: Kesra Jdida meaning New Kesra)	750 m (one way) 1.5 km (both sides of the road)	Start point (35.7993583; 9.3575856) End-point (same as start point)	A) - Partial sidewalk; - Main road is used for walking on market days; - Quality rating 2 B) 40 bushes and trees	A. Fresh fruits and vegetables' open space weekly market B. Convenience stores: 8 C. Vendors/street stands/snack food shops: 3 (popcorn x2, candied peanuts) D. Specialty store: 2 (spices, legumes and nuts) E. Bakery: 1 F. Pastry shop: 1 G. Cafes/fast casual restaurants: 2 H. Sit-down restaurants: 2	A) Food/snack foods: 6 (3 ice-cream, 1 chocolate, 1 mix and 1 nuts) B) Sugary drinks: 1 (from mix ad)

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Market Observation Routes



The market observation route started from a street where market stands were visible going along the streets where most of the stands were visibly located until the end of the row of stands along a different street. In Kesra the end point merged with the start point of the observation route. Routes were drawn after the market surveys were completed.

Quality of Sidewalk in Gaafour



Food ads in Gaafour



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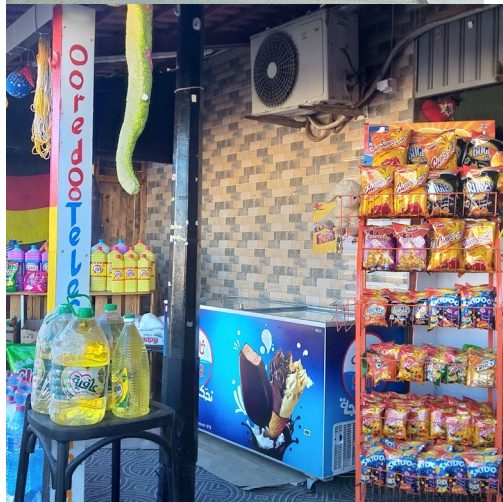
Quality of sidewalk in Sers

Sidewalks are often covered by items from sellers or their stands. Some parts are broken, some parts are well maintained, but overall sidewalks are uneven as patches are not similar to one another. Rating 2.5 out of 4. Street is by shoppers instead of sidewalks on market days. Some shoppers carry handcarts that roll on tires to load their vegetables. Mothers with strollers for their children are commonly seen.



Food Ads in Sers

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Food Ads in Makthar



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Food Ads in Kesra



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Packaged Snacks Assessment



The packaged products observed were sweet wheat-based biscuits/cookies with saturated fats. Tom and Saida brands appear to be popular and ubiquitous.

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Nutrition Facts panel

Text is too small and its color contrasts poorly with that of the background. This makes it extremely difficult to read the information. The nutrient break down per 100g of product requires calculation to estimate the nutrients per piece in the package.

Major ingredients for the selected products are: wheat flour, sugar and saturated fat (palm oil or hydrogenated vegetable oil).

Restaurant Assessments

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Gaafour



(coordinates: 36°19'25.1"N,
9°19'17.9" E)

Medium-low income sit-down
restaurant

Menu highlights many chicken-based dishes such as chicken sandwich, whole, half or quarter chicken, tuna sandwich, vegetable sandwich, spaghetti with tomato sauce, and drinks like soda, water and fruit drink.

Ads and the menu highlight sandwiches with at least 5 out of 12 total items having chicken. Vegetable-based dishes (Tunisian salad with eggs decorated with tuna, 2 out of 12) are listed at the bottom of the menu.



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Keftaji Sandwich has about 6-8 servings of white bread with 1 serving of vegetables spread inside with sauce, fries and olives.

Chicken dish has no vegetables but two appetizer plates are offered amounting to about 3 servings of vegetables. Spaghetti is mixed with tomato sauce with minimum 4 servings of white grain.



Sers

Located amidst the fresh market, a pizza restaurant offers pizza, burgers, fries, pasta, and sandwiches. Prices are comparable for some items to other restaurants but higher for some other items such as drinks being 1.5 compared to 1 dinar in medium-low budget restaurants.



The pictures and symbols decorated inside and outside the restaurant hint to the obesogenic types of food served.



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A local restaurant close to starting point (GPS coordinates: 36.0733169, 9.0192031) is selected for lunch. Menu items show

Cost of main choices range from 2.5 for salami in thin oily bread, 3 for tuna and turkey ham oily wrap, 4 for egg tuna roasted pepper spread with olives and seasonal vegetables (e.g. cabbage) to 5 for fish and sausage with one special item priced at 8 dinars.



A menu item ordered has an estimated 6 to 8 servings of white bread. The filling appeared to contain 1 serving of salad with an estimated 1.5 to 2 servings of liver. Half a serving of vegetables in the form of harissa (hot pepper paste) and grilled green pepper spread, is estimated.



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Makthar



A randomly selected restaurant in Makthar was located at the end of the community observation walk close to the local bakery and the grocery store. The menu highlights sandwiches made with any combination of tuna, cheese, eggs, salami, and breaded chicken in addition to pizzas including one choice of vegetarian pizza with mushrooms, olives, and for toppings.

Prices for menu items were comparable to similar restaurants in other communities. Fries were listed as an item but no salad dishes were listed on the menu. Except for a single tomato drawing and bottled water on the menu, food pictures on the menu and outside the restaurant showcase high calorie low-nutrient density foods and sugary drinks.

Kesra

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طابونة			شباتي			سندويتش		
2500	طابونة كفتاجي	2000	شباتي سلامي أملت	2000	سندويتش تن	2500	سندويتش تن	2500
2500	طابونة تن	2000	شباتي تن أملت	2500	سندويتش تن سلامي	2500	سندويتش تن فريت	2500
3000	طابونة أملت تن	2500	شباتي تن أملت فريت	2500	سندويتش تن أملت	2500	سندويتش تن أملت فريت	3000
3500	طابونة إسكالوب	3000	شباتي أملت إسكالوب	3000	سندويتش تن أملت فريت	3500	سندويتش إسكالوب فريت	
		2500	شباتي سبيسال					
			شباتي تن دويل أملت					
محن								
3000	محن تونسي							
2500	محن كفتاجي							

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Picture above is of Assalam restaurant.



Qertaj Restaurant

The first restaurant visited in Kesra appeared to target youth adults and teenagers. Menu choices included tuna, breaded chicken, eggs and a combination of these served in different types of white bread and fries. There are two items with vegetables (11% of menu items despite all pizzas excluded). The menu highlights high calorie low-nutrient density food choices such as white bread with fries and tuna, salami omelet sandwich, breaded fried chicken with fries sandwich and the same items in a different type of bread with the choice of sodas and water as drinks at a uniform price in all the restaurants visited.

Assalam Restaurant

The second restaurant visited offers meals similar to mainly non-vegetarian home-cooked meals prepared and managed by a woman. Some items such as beans with lam were not available. Prices seemed higher than the fast food restaurants on average (5.7 in Assalam vs. 2.67 in Qertaj) with more expensive ingredients such as lamb meat and jute mallow (although not available) in Assalam restaurant than in Qertaj restaurant.

Food ads in both restaurants showcase high density foods and sugary drinks with Assalam showing more vegetables in a burger and wrap and Qertaj showing a plate of Tunisian salad in only 1 out of 4 ad spots.

Observations in Grocery Stores

The grocery stores in Gaafour, Sers and Makthar belonged to a chain store called Aziza. The store offers a variety of packaged products, highly processed baked sweet grain products such as biscuits, fruit flavoured drinks with fruit juice containing a maximum of 30% from fruits in tetra packs. The selection of fruits and vegetables is placed towards the end of the store on a relatively small rack (ratio of vegetable rack to one row of baked products by observation appeared to be with optimistic estimates (favoring vegetables and fruits) 1:4 in length. The

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quality was poor for around half of the vegetables on racks. The grocery store carried a few items that were not observed in the fresh market such as eggplants, garlic, and kiwi.

Ads for sugary drinks were visible at the point of sale. No ads for fresh fruits and vegetables or whole grain products were displayed. The pictures are more like a visual for the different sections in the store than advertising for the products within the store especially in Makthar. The pictures, for example, show cake, oil, yogurt, cheese, spaghetti and meat sauce, water, and pastry. The vegetables and fruits are tucked far away from the entrance and are not visible from outside. They appear to have good quality.

Permission for taking pictures was not granted by the store manager who was reached by telephone by an employee upon our request in Sers. Permission for costing food items was granted by the same manager. The same grocery store was observed in Makthar but no costing activity was performed, as the prices did not appear to be different from those at the same grocery chain store in Siliana.

Focus Group Findings

On average focus groups lasted 70 minutes.

Participants

A total of 38 (15 women and 23 men) persons in four communities participated in focus groups facilitated by one to two local researchers and another researcher based outside Tunisia. The table below shows information about the participants. The education system in Tunisia includes 11 years of schooling as compulsory basic education followed by 4 years prior to entry into university or technical college, which can take two to 5 years to complete depending on the profession. The average years of education in school setting was 7.32 years. Seven people had received no education. If these participants were excluded from the average, it would raise to almost 9 years of formal education. Overall, women's formal education was significantly lower than that of men's. Prevalence of obesity among the participants was 24%. When asked about their weight and height, 49% of the participants did not know their weight while 38% did not know their height. Only one person, whose reported height and weight placed the person in obese category.

Table 7. Focus groups' participants' demographics

	Total	Percentages	Women	Men
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Participants	n=38	100%	15	39%	23	61%
Age ranges						100%
18-30	2	5%	0	0%	2	%
31-50	20	53%	10	50%	10	50%
51+	16	42%	5	31%	11	69%
Marital status						
Married	32	84%	13	41%	19	59%
Single	6	16%	2	33%	4	67%
Divorced/widowed	0	0%	0	0%	0	0%
Education Level (years in school)	7.32		5.73		8.52*	
No. of children on average	2.7		2.7		2.8	
Household size	4.4		4.3		4.4	
Person(s) in charge of food preparation			37	97%	1	3%
Person(s) in charge of Food budget	6 (both genders)	16%	2	5%	30	79%
Person in charge of shopping	14 (both genders)	37%	5	13%	19	50%
BMIs						100%
<18.5	2	5%	0	0%	2	%
18.5-24.9	13	34%	4	31%	9	69%
25-29.9	14	37%	7	50%	7	50%
30+	9	24%	4	44%	5	56%

* significant difference at $p < 0.05$

Findings from focus group discussions

Participants were asked to list the foods that they believed were good for their health. The graph below (Figure 1) shows the components of the food items that the participants in the various focus groups provided.

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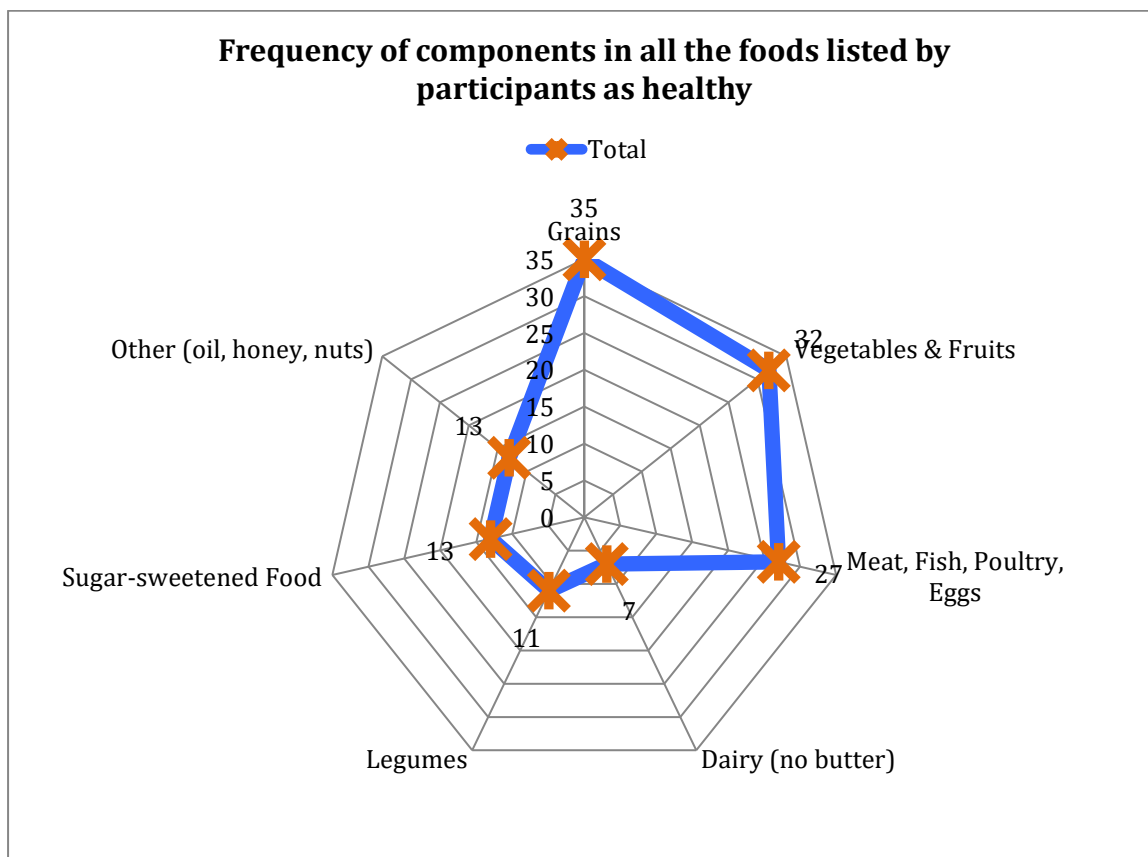


Figure 1. Frequency of appearance of the listed type of food components in the list of the healthy foods as perceived by participants in focus groups across four rural communities

In order of appearance in the list, the top five foods contained the following (Figure 2) components based on food groups of interest:

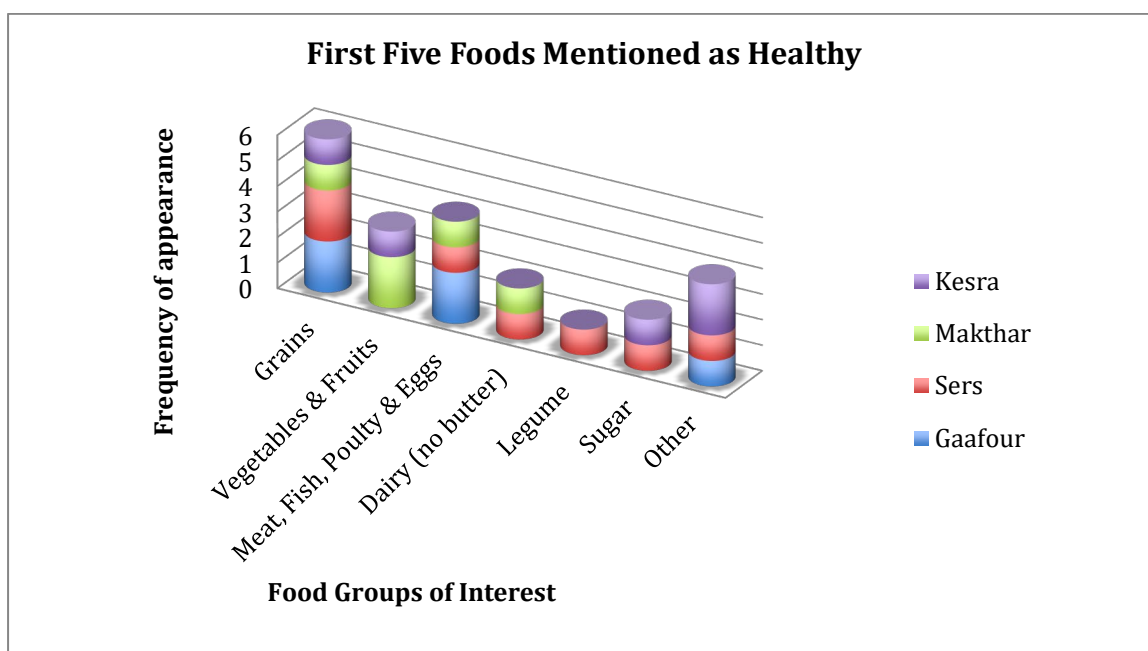


Figure 2. First five foods mentioned as healthy in focus groups across four communities

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Perception of Healthy Foods

“Wheat is a blessing!” (Participant 2, male, Gaafour)

Participants believed that a whole range of grain products were healthy. These grains included wheat in the form of bread, couscous, cream of wheat, bulgur and some other shapes of wheat, barley and sorghum. The statement that “Wheat (representing grains) is a blessing” (participant2, male, Gaafour) demonstrates this belief agreed to by other participants in the focus group in Gaafour. Although most of the participants did not differentiate between white and whole grains, upon further prompting they stated that they believed whole grain products to be healthier. In Sers, the participants (mostly women with one young man) pointed to how white bread has replaced whole wheat and barley bread, which were consumed regularly in the past. Similarly, another participant shared proudly how his wife and some other people in his community mix whole grain with white flour to bake bread (participant 36, male, Kesra).

Surprisingly, participants in all communities listed some foods that are sweetened with sugar as health promoting such as fig jam, aseeda (a sweet dish like pudding), mbassa (sweet bread made with oil), and bsissa (whole grains with legumes, nuts mixed with sugar and olive oil) among others. Participants did not view sugar by itself as health promoting food as expressed by a participant in Makthar who viewed packaged products unhealthy because “there is more sugar in them.” However, the perceived benefits of grains appeared to overshadow the negative effect of sugar on health.

“Nothing replaces meat!” (Participant 32, male, Gaafour)

Participants mentioned different types of animal products as health promoting including lamb meat, beef, goat, fish, butter, specifically local eggs, poultry, and fresh butter. Animal flesh and eggs, not including dairy products except for butter, were the highest mentioned food types believed to be healthy after grains and vegetables but they came second from the top in the first five foods mentioned in the list of health promoting foods. One participant indicated lamb meat in small quantity and not much fat (female, Kesra) as being healthy.

Milk was considered important for the health of children. The statement that “two litres of milk is better than two kilos of dates” (Participant 4, male, Gaafour) attests to this belief. Priority is given to children when it comes to milk with leftovers drunk by adults (Gaafour).

“Using Arbi eggs!” (2 male participants, Kesra)

The word “*arbi*” was used as a highly valued quality for foods. It refers to locally and naturally produced foods. It was used with reference to eggs, chicken, butter, milk, couscous, *mhamassa*, bread, *mbassis* (sweet bread) as well as chard and

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cardoos, in whose case it referred to naturally grown or uncultivated type of these vegetables.

This perception was accompanied with mistrust of “chemicals” (Gaafour, Makthar, Sers), referring to herbicides and pesticides, treatments. For example, barley was considered healthier than wheat because unlike wheat, no herbicides are used prior to seeding barley (male Participant in Gaafour). Participants also perceived home-made food healthier than that sold in restaurants or shops as packaged or conserved food. They expressed concern over the amount of canned foods available now compared to 20 years ago (Gaafour, Makthar, Sers). Home-made food was also praised for being cleaner than that prepared outside the home setting.

Factors influencing perceived healthy food consumption

The following table (Table 8) provides a description of the factors perceived by participants as influencing their consumption of healthy food:

Table 8. Factors influencing participants’ diets

No.	Factors influencing perceived healthy food’s consumption	Examples from focus group discussions
1	Availability Availability of perceived healthy foods was affected by a number of factors that are listed in the graph below this table.	<ul style="list-style-type: none"> - <u>Low precipitation</u> affecting availability of various foods. For example, “[we used to collect wild mushrooms], but now we cannot find it [because of decreased biodiversity]” (Participant 15, female, Sers). Participants in Gaafour echoed the same concerns regarding collection of mushrooms, snails and cardoon. - Low precipitation also causes the food prices to rise in the market, which affects consumption of healthy foods. - Availability in <u>close proximity</u> to the participants was also influential. For example, regarding local chicken, participants in Sers said that it’s always available (they have their own [local chicken] and also in their neighbourhood). - <u>Competition for wild edible plants</u>: Animals that graze in olive orchards on the one hand provide manure to the trees naturally, but on the other hand, they eat the vegetables that humans used to gather for themselves. (Participants in Kesra) Also,

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		<p>sellers collect the vegetables from the wild and sell them in the market leaving not much wild vegetables for the locals' own consumption.</p> <p>- <u>Sale arrangements</u>: "Now forage is expensive, so farmers are obliged to sell their milk to get forage" (Participant 15, female, Sers). Milk collectors pay for the milk by providing fodder to the dairy farmers, so fresh milk is not available for making fresh butter.</p> <p>- <u>Money-based economy</u>: "In the past when someone worked for another farmer for harvesting, he would get a part of the harvest as payment, which he ate. So he was eating healthy. Now they earn money instead, they do not eat healthy. They eat other things." (Participant 21, female, Sers)</p>
2	Trust Lack of trust in food products as being pure and not mixed with other products prevents participants from purchasing certain items.	<p>"No one is selling [barley bread] in Kesra except for one bakery, which we don't trust [if barley bread is really made of barley]" (Participants in Kesra).</p>
3	Accessibility Ease of access to perceived healthy food facilitated its consumption while poor access or difficulty in accessing it, prevented participants from obtaining it.	<p>- Participants believed that <i>raeb</i> (fermented milk product) was not easy to get. They had to get to another area to get this product from a farmer. "We have to take a taxi to get there" We need to tell the <i>raeb</i> seller to order it a day ahead so that it can be available for us to pick up the next day. In the past you could find cattle in every house, but now there are fewer houses with cows." (Participant in Kesra).</p> <p>- Fish is only available once a week in the market on Saturday; if desired on Monday for example, they have to travel further. (Gaafour)</p> <p>- "Buying cream of wheat to bake bread at home is easier than getting whole grain wheat flour to bake bread" (Female participant in Sers).</p>

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4	<p>Price</p> <p>Perceived high price of foods discouraged their purchase.</p> <p>Nonetheless, it did not prevent purchasing of valued foods such as lamb.</p>	<ul style="list-style-type: none"> - Olive oil is expensive (Sers) - “[Regarding red meat] we eat meat very little” (Participant 19, female, Sers) - Fruits: If price is high, it is a barrier. Priority is given to vegetables. - “[Lamb meat is] very expensive but all people in Kesra are buying it.” (Male participants in Kesra)
5	<p>Food habits & traditions</p> <p>Participants pointed to food habits, traditions and preferences as strong factors influencing food choice.</p> <p>For example, making couscous is what participants are used to doing on market days when they acquire vegetables from the market.</p>	<ul style="list-style-type: none"> - “We prefer bsissa over sorghum” (Female participant, Sers) - Regarding preparing couscous with many different kinds of vegetables and meat: “tonight [the day of the market] I prepare couscous” (Female participant in Sers). - “On market day, they [the women] always prepare couscous. Use of chicken or meat is determined by how much a family can spend” (Participants in Makthar). - [salted olives] is part of our food habits (Female participant in Sers) - “[Dried figs are] not locally grown therefore people are not used to consuming it regularly” (Female participant in Sers). - “We know healthy and unhealthy food but because of habits, we eat unhealthy” (Participant 6, male, Gaafour)
6	<p>Ease of preparation</p> <p>Foods that are easy to prepare are consumed more than those that require more effort to prepare.</p>	<ul style="list-style-type: none"> - “when the woman has nothing to cook dinner [...] just cut some peppers, carrots, onion and cucumber, put some olive oil and salt [and you have dinner]” (participant 21, Sers) - Drying figs is a problem because at times there is not enough sun to dry the figs properly. (p39, kesra) In Kesra there is a problem of humidity making the drying of figs very difficult.

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		<p>- “Wheat is easier to make dough while barley requires more effort.” (Participant 3, female, Gaafour)</p> <p>- For preparing soups (barley soup or other soups with chickpeas, dried fava beans, etc) “all [ingredients] are available and easy to prepare.” (Participants in Kesra)</p>
7	Flexibility of the food item	“We buy chicken and we don’t buy fish, because one chicken can make 2 or 3 meals, but when we buy one kilo of fish, we just cook it once” (Female participant in Sers).
8	Knowledge of/confidence in particular foods’ preparation Familiarity with preparing a food item facilitated its consumption.	<p>“Preparation methods [for bulgur] are well known and practiced” (Female participant in Sers).</p> <p>“[Tegin] can be easily prepared at home” (Participant in Gaafour)</p>
9	Time poverty Participants pointed to the unavailability of time dissuading engagement in preparation of healthy foods.	<p>- “Some women do not have the time to prepare [barley bread]. Women want to cook with less effort” (Participant 34, male, Kesra).</p> <p>- “Problem of preparing and cooking some food because women now don’t have enough time to prepare some of these foods” (Participants in Kesra)</p> <p>- “It’s the problem of time. They don’t have time to prepare home-made foods.” (Female participant, Sers)</p>
10	Personal preference vs. obligation to cater to family members’ preferences Food preference encouraged certain food choices over those that were not preferred.	<p>- People prefer lamb meat over goat (Female participant in Sers).</p> <p>- In the past we used to eat it [traditional butter] but now we don’t eat it and the children do not eat it, because of the bad smell. Since packaged products industry came into market: packaged milk/yogurt/cheese/juice. (Participant in Makthar)</p> <p>- Olive oil and fresh (local) milk: “children do not like them. In the past, they would</p>

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		have them but now they don't. Children now want packaged milk." (Participant in Makthar)
11	<p>Children's food likes/dislikes</p> <p>This appeared to be at the core of what women as mothers prepared for the family.</p> <p>Men said that women have the choice of what to prepare with what is purchased from the market.</p> <p>While Participant 11 (male, Makthar) said it's 100% in the women's hands, other participants gave various answers such as:</p> <ul style="list-style-type: none"> - it depends 50% on women and 50% on children, - 50% on women, 40% on children and 10% on men - "If there is an old man in the house, we will ask him what he would like to eat daily, because he is sick and maybe he cannot eat every thing" (Participant 2, female, Makthar). 	<p>- "[Kadid is healthy] but we do not cook it, because the children do not like the smell. (Female participant in Makthar)</p> <p>- "I already know what my children want." (Female participant, Makthar) [so I prepare the meals according to their likes].</p> <p>- "If they [the children] don't eat, their mother cooks eggs for them." (Male participant in Makthar)</p> <p>- "If she likes a food that her children don't like, would she avoid cooking that?" (Researcher)</p> <p>"Yes. They would cook something different for their children. Yes. They would avoid cooking that." (Researcher Assistant interpreting the responses from participants in Makthar)</p> <p>Q: Who is the best person to change your habits? Or help you change your habits? A: Children and wives. (Makthar)</p> <p>- One participant said that even if she doesn't have time to cook and her husband comes. He just eats olive oil and bread and says it's fine.</p> <p>- "Children want to eat sweet food." (Male participant, Kesra)</p>
12	<p>Popular Media</p> <p>The effect of television and social media on food choices was acknowledged in focus group discussions.</p>	<p>- Eating habits have deteriorated over time especially with the effect of TV, social media and advertisement of unhealthy foods affecting children. (Sers)</p> <p>- On TV they [children] see ads for unhealthy food. Advertising is influencing the children's preferences (Participant 34, male, Kesra)</p> <p>- Facebook and the like are also influencing (Participant 33, male, Kesra)</p>

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		<p>- “They like to eat the packaged products in the ads that they see on TV.” (Male participant, Kesra)</p> <p>“Children now prefer to eat white couscous rather than whole wheat couscous.” (Male participant, Kesra)</p>
13	School Teachers were deemed important in shaping children’s choices.	<p>“When children take food to school, when they are given home-made food, they refuse it and want packaged food.” (male participant, Makthar)</p>
14	Religion Participants were asked about whether their religion affected their food habits. Special times like Ramadan, the month of fasting, Eid festivals and the first day of lunar calendar were the religious events highlighted regarding the choice of food that was prepared. When asked about food waste during Ramadan, while some participants acknowledged that there is relatively more food waste during the holy month, others said this is not the case at least not anymore due to poor economy. Leftovers are kept in the fridge and consumed the following day. <i>Observation:</i> Although at first the participants said there is no relationship between their faith and what they eat, when Ramadan was mentioned, participants shared how the foods they eat would be different during Ramandan	<p>“our religion is against food waste” (Participant 3, male, Gaafour)</p> <p>“There was more food waste when economy was better but now because of the economic crisis, there is less food waste if at all.” (Male participants, Gaafour)</p> <p>“[Food wasting during Ramandan] is not happening, because women know how much to prepare. Also, the leftovers are consumed. Women who have time they prefer to make home-made food like bsissa and sorghum to save on food budget.” (Female participants, Sers)</p> <p>Participants in Kesra and Makthar shared the following regarding the food traditions related to religious special occasions: “First day of the lunar year, mloukhiya is cooked.” “During Eid adha meat is cooked.” “For Eid or all celebrations, we prepare couscous with lamb meat.” “In Ramadan, we eat more soups and brik (deep fried potato egg filled wrap).” “More number of dishes are cooked in Ramadan. All day cooking different types of dishes and then not usable food [is] given to chicken[s].”</p>

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	compared to other months in the year.	<p>“On Eid-fitr we eat more sweets.”</p> <p>In Makthar, the participants shared the following regarding food consumption in Ramadan:</p> <p>“In Ramadan things change 180 degrees” (Participant 32, male, Makthar)</p> <ul style="list-style-type: none"> - “more brik” - “more fried food” - “many kinds of food” - “food waste”
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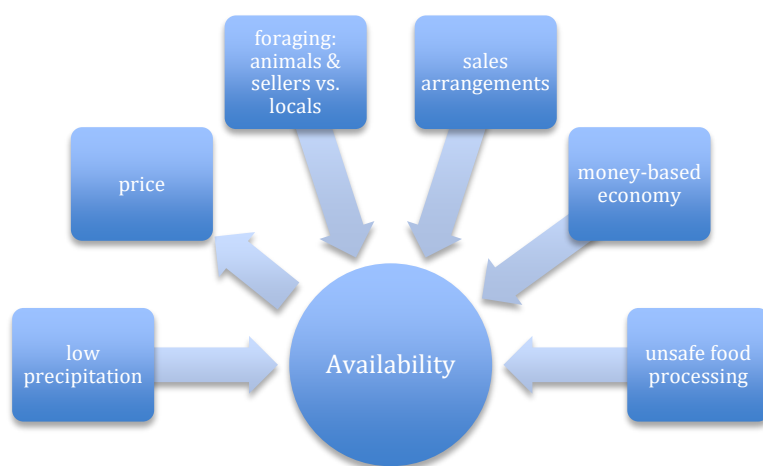


Figure 3. Factors influencing and influenced by availability of food items as perceived by participants in focus groups across four communities

Perception of sustainable foods

It appeared that when participants were talking about healthy food, they did not think about environmental consequences of the foods they listed as being healthy.

For example, in Sers, when asked whether any of the foods listed as healthy on a flipchart paper would cause any harm in whatever way to the environment, the participants stated that “none” had any negative environmental impact.

However, upon further probing, participants mentioned “idawi” or chemical treatment (Participant 15, female, Sers) of plants having negative environmental impact. Participant 15 stated that a lot of pesticides were used by farmers to compete in producing more quantities of vegetables. In Gaafour participants mentioned how chemical treatments used for fruits and vegetables damages the environment. Another group stated that if vegetables are grown organically,

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they are good for the environment. However, “some farmers in Shwarniye (a farming area in Makthar) apply chemicals when growing vegetables, which is not good for the environment” (Male participant in Makthar). The following quotes indicate how organic is valued by the participants by way of upholding sustainable foods:

“When they grow barley, fruits and vegetables they require chemical treatment, so it damages the environment” (Male participant, Gaafour)

“Wheat can damage the environment because all farmers who cultivate wheat are using chemicals. If everything is bio, it’s good for the environment; if not, it will damage the environment.” (Male participant, Makthar)

“Fruits are similar to vegetables: if they are bio, it’s good. If not, they will damage the environment.” (male participant, Makthar)

“In Europe they stopped using chemicals” (Participant 26, male, Makthar)

“The agricultural practices have changed [in negative way]” (P 15, sers). “in the past they used sheep manure [instead of chemical fertilizers]”.

When asked why snails are considered healthy, participants in Kesra responded by saying “because it’s natural and bio.”

“Figs are available in both Kesra and in other places, but Kesra’s figs have a special taste. They are cultivated without chemicals and are bio.” (Participant 33, male, Kesra)

A participant in Makthar stated how a type of plant called Khobbeeza, collected from the wild, was no longer available because of its lack of resistance to herbicides. This is how, the participant reasoned, the use of chemicals affect biodiversity negatively.

Fava beans and olive trees were mentioned as good for sustainability because olive trees are cared for without the use of pesticides and fava beans are not only grown without [chemical] fertilizers, but also enrich the soil with nutrients (Participants from Makthar & Gaafour). Regarding chemical fertilizers, participants believed that the use of sheep manure, as was practiced in the past, was not harmful to environment.

Participant 13 pointed how growing vegetables and fruits had negative environmental effect as they “require a lot of water” (female, Sers).

Local chickens were praised for cleaning the soil from harmful insects (Male participant, Kesra). Similarly, local chickens were considered healthy as stated by participants in Sers: “In the past there was more local chicken but now there is more other [industrially grown] chicken [that we eat]”. This was followed by

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the statement that people in the past ate healthier than what people eat nowadays in their community.

Legumes as meat alternatives

In exploring the concept of using legumes as meat alternatives, the participants presented various opinions:

- Legumes are already part of their diet and are used in the dishes they normally eat:

"In couscous, soups and mohammsa these legumes are always used. These meals are usually eaten in winter." (Gaafour)

"in Leblabi (a local dish with boiled chickpeas, harissa, egg, pepper paste) and hot soups (eaten in Winter)" (Gaafour)

"for couscous (with fava beans and chickpeas), for jari (liquid meals: soups)" (Makthar)

"daily use [of legumes]" (Male participant, Makthar)

- Legumes can be nutritious:

"Fava beans and chickpeas can be used instead of meat. They can even be healthier than meat" (Gaafour)

"They provide iron for the body" (Sers)

- Perceived meat substitutes included:

Chickpeas, lentils (Gaafour, Makthar), fenugreek, favabeans, eggs (Sers, Makthar), milk, fish

"Fish can replace meat. Sometimes you go to buy meat but when you see good fish you buy that instead. Fish is cheaper than meat and better." (Male participant, Kesra)

"Even nutritional value of fish more than meat" (Participant 33, male, Kesra)

"maybe we can replace them with "hashish" (leafy greens e.g. swiss chard, parsley, etc)" (Participant in Makthar)

"My mother- when she cooks with meat, she doesn't put legumes and vegetables but when she cooks without meat, she puts a lot of legumes and vegetables." (Participant 39, male, Kesra)

- Legumes with meat is more nutritious:

Working Document

"A meal with meat and legumes is more nutritious. This is how we preparing meals with both." (female participants in Sers)

- More economical but still expensive:

"Legumes are cheaper than meat." (Gaafour)

"Chickpeas are very expensive- 9 dinar per kilo" (Male participant, Makthar)

Do not need alot of water for cultivation:

"Legumes do not require a lot of water" (2 participants in Sers)

Legumes cannot replace meat:

"Nothing replaces meat" (Participant 32, male, Makthar & a male participant in Kesra)

Local chicken can be a good replacement" (2 participants in Kesra)

"We know that meat is unhealthy especially its fat, but we continue to eat it." (Male participant, Kesra)

How food habits can be changed

Participants were asked about what could help change people's dietary habits so they could eat healthy foods more often. Participants in all communities pointed to children influencing the choice of meals that were prepared by mothers. When women were asked about why they prepared foods according to their children's likes rather than preparing healthy foods, they said that "If the food is not liked by children, they will not eat and it hurts the [mothers'] feelings when the children go to bed hungry" (Participant 1 and 2, females, Gaafour).

When asked what could change the children's food habits, participants said by:

- **guiding them:** "you can talk to them softly" (Participant 15, female, Sers). This was also echoed by participants in Makthar.
- **mixing what they don't like with what they like:** "For example, if they don't like honey, you can put it in their milk" (Participant 16, female, Sers).
- **leading by example:** "When children see how other family members eat healthy food, then they will be convinced to try it too." (female participant, Sers)
- **removing junk food from home:** "when you don't buy unhealthy food, your child will not find unhealthy food in the kitchen so he will not eat it" "we should just buy healthy products" (male participant, Makthar)

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- **influencing children's diets through educating mothers or children's caregivers:** "In Kesra the mother is the first one to influence the child but in other places where the women are working, so they are not the first people to change a child because they spend time with the teachers and the fathers also" (Participant 39, male, Kesra)
- **Teachers and doctors can influence children:** "When parents do not buy food for their children that teachers ask, the children become embarrassed" (Participant 39, male, Kesra). Unfortunately, "Most of the teachers ask students to bring unhealthy packaged food." (Participant 36, male, Kesra)
"When the teacher tells the students to bring healthy food to school, they tell the family to give them" (Participant 23, female, Makthar).
- Also, participants in Makthar stated that when they take their children to the doctor, the children listen to the doctor.

Male participants indicated that women were influenced by their circle of relatives and friends as well as broadcast media:

"media, TV (drama series), by calling others: one is in Tunis and one is in Kesra and talk to each other" (Participant 39, male, Kesra)

In general, participants stated that "When you want someone to change their eating, you can tell them about the benefits of that food, like it's healthy, it doesn't cause diseases" (Participant 21, female, Sers). This highlights the value of providing nutrition education. Furthermore, "Food practices in a community can change the food habits of a person in the community." (Male participant in Gaafour) Confirming this Participant 12 in Sers stated "When a neighbour is cooking something like mloukhia and you smell it, then you also want to cook it." This may simply point to sensual attraction, which was further emphasized by Participant 3 stating that "by tasting a new food, it can be liked and adopted".

Perceived needs from research and development oriented agencies

A number of participants in the focus groups expressed interest in learning about nutrition and food related topics as well as training in food production.

In Sers at the cooperative of women farmers where a focus group discussion was conducted, participants stated that "older topics [covered at the cooperative centre] were about agriculture but this is about something [food] that is a daily issue" (Participant 21, Sers). "We seed only once a year but we eat every day" (participant 15, Sers).

Some participants said that they knew some things about nutrition, which due to lack of time were unable to implement them easily (Sers).

"We talk about agriculture alot but not about food [so it is nice to see this topic being brought forth in our community]" (Participant 8, male, Gaafour)

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Surprisingly, one participant shared how he felt “psychologically better when talking about this [food topic]” (Male participant, Gaafour).

Discussion

This study provides a systematic approach in assessing foodscapes that includes a food environmental review triangulated with personal factors elicited from local residents of the corresponding communities. Foodscapes study has been highlighted as requiring multi-component studies (Caspi et al., 2012; Turner et al., 2018). The present study adapted various tools to assess the foodscape in Tunisia, a low-middle income country in North Africa. While the effect of foodscape from a spatial approach on diet has been documented (Calry & Kestens, 2017; Burgoine et al., 2014), personal variables have also been pointed out as modulating this effect explaining the mixed effect of foodscapes on health and diet (Méjean & Recchia, 2022). Thus, personal variables need to be incorporated into the design of any intervention aiming at increasing sustainable dietary practices.

Sustainable diets

Modeling dietary changes that would result in reductions in environmental impact of diets in Tunisia indicated that for Tunisians' diets to become more sustainable the following dietary shifts would result in reductions in environmental impact while maintaining the nutritional parameters for a healthy diet (Perignon et al., 2019). Below are some of the changes required among others to reduce the environmental impact of diets in Tunisia in general:

- reductions in meat, offal and poultry consumption (from 71g to less than 4g all combined)
- increase in the amount of legumes (from 16g up to 36g)
- reduction in the amount of soft drinks (from 47g down to nil)
- increases in the amount of both vegetables and fruits (from 381g up to 613g and from 216g up to 613g, respectively)

It should be noted, however, that the observed dietary data's source in that study was obtained from a nationally representative sample in Tunisia in 2005, which probably does not reflect the dietary changes in recent years nor does it reflect differences across various regions in Tunisia. Nonetheless, the recommended target amounts can still be relevant.

The focus group data in the present study showed the belief in the health promoting effect of various animal-sourced foods namely butter and animal flesh, grains and vegetables. Thus reducing animal source foods to nil would be extremely challenging. Increasing legumes, on the other hand, would be less challenging as it is already part of the diet and is considered healthy as revealed in focus groups' data. For sustainable diets to be adopted, they need to be available, accessible, affordable, and acceptable.

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Availability and accessibility

The costing tool listed items that were included in the DQQ survey. Although the list covered a number of vegetables and fruits based on most commonly available produce in Tunisia, it did not cover all available vegetables which possibly excluded some vegetables available in the market but not in the list. Also, some of the fruits and vegetables in the DQQ were not available in the market as they were off-season. Thus a DQQ-based costing tool may not capture information about all the products available in the market. However, there is enough variety of vegetables and fruits in the DQQ that can capture diversity of diet regardless of seasons.

Nonetheless, it should be noted that seasonal variations in food intake is shown in farming communities in Tunisia with significantly lower consumption of dark leafy green vegetables, vitamin A rich fruits, and other fruits in the summer and fall compared to winter and spring seasons (Gaillard et al., 2022). Since the survey conducted was in winter, it may overestimate the availability of dark leafy greens and fruits as well as underestimate their price compared to summer and fall seasons.

Regarding the sale of ready-to-eat snacks and foods in food outlets such as restaurants, street food vendors and convenience stores, refined grain products such as biscuits, chocolate, processed meat and egg-based dishes were common. A study of 35 restaurant food recipes in Bizerte in northeast Tunisia showed that 43% of the recipes were actually nutritious (class 1 category in the French SAIN, LIM nutrient profile system) with 49% assessed as fitting class 3 and 4 (less nutritious or lower nutrient density foods (Thabet et al., 2021). In the present study, only one restaurant per community was observed, which does not provide an adequate sample of all the restaurants in any of the communities.

Nonetheless, the selection of the restaurant in close proximity or in the market area translates into the exposure of the selected restaurant to a larger number of people at least on a weekly basis during fresh market days than any other restaurant in the community. Therefore, the selected restaurants were expected to be highly visited by virtue of their location.

Milk was not as visible in stores as sweetened yogurt was. Surprisingly, in the focus group discussions, unavailability of milk was not always perceived to be present. Participants pointed to how they could acquire milk from farmers in their neighbourhood if they did not own dairy cows themselves. Thus, availability of fresh milk and unsweetened dairy products like yogurt may be an issue in urban areas rather than rural areas where dairy production may exist. Regarding accessibility, participants mostly agreed that it was not an issue for obtaining the foods they perceived healthy. The frequent daily trips made by shared-taxis across all communities confirmed this. Obtaining *raeb* was pointed as being difficult as participants obtained it from another community and because it had to be ordered a day ahead and picked up the next day, which limited participants' access to *raeb*.

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The existence of sweetened products in convenience and grocery stores appears to go hand-in-hand with the increase in sugar and sweeteners and animal fat intake of Tunisians over multiple years according to the analysis of household data (Doggui et al., 2020). While food environment has certainly been shown to influence dietary intake, individual level factors have also been shown to be influential in shaping individuals' food intake in the context of a low-middle income country (de Menezes et al., 2018). Therefore, it is important to put weight on individual-level interventions as long as the external factors in the food environment are not prohibitive.

Cost of food

In measuring the cost of food, the food list from DQQ was used. There were some challenges due to the unavailability of certain fruits and vegetables such as melons, lim hlou, and apricots that are seasonal as well as grains such as barley and oats. These grains may be available from specific stores or generally purchased in bulk following harvest along with olive oil as shared by a research assistant who was a local resident in one of the communities. Thus the price of these items may be higher than what the residents actually pay when buying in bulk after harvest. Also, the DQQ does not have oil in the list of foods, which was added to the food cost survey as a basic essential for households. The cost of the same diet in Makthar appeared to be highest relative to other communities. This is because there is a daily smaller market as well as a once a week large market where prices are probably cheaper. The survey was conducted in the small daily market as opposed to the crowded market day. In Gaafour, the fish market is not on the same day as the fresh vegetable and fruit market, which prevented us from getting the cost of fresh fish. Another issue in doing food cost survey that we faced in two communities was in few instances after the cost of the item was recorded, a researcher wanted to purchase the same item that was priced, but the seller increased the price when the researcher wanted to pay. In these two instances, the price was adjusted to show the real cost. It is possible that sellers artificially reduced the price when asked by researchers who recorded the prices. Regulations for the vendors require making prices visible for customers. So some of the vendors who did not display prices were possibly cautious of researchers' presence. Furthermore, local researchers indicated some vendors who were potentially selling items without vendor permit or exclusive of their permit from Algeria. Researchers did not approach such vendors who may sell products for lower than normal prices elsewhere.

The cost of refined grains in Makthar and Sers was higher than that of same food group in Gaafour and Kesra due to high price of rice in the former two communities as brand names like Basmati rice, low price in Gaafour without a brand name and no rice found in Kesra. Furthermore, the average cost of dairy was lower in Gaafour as no cheese was found on the market day in Gaafour. Cheese seemed to be more expensive per serving than any other dairy product.

Working Document

Acceptability

According to Caspi et al. (2012) acceptability encompasses “people’s attitudes about attributes of their local food environment, and whether or not the given supply of products meets their personal standards.” Hence, acceptability is mainly a subjective measure of food environment and quality. In the present study, the findings from the focus groups shed light on what the participants’ attitudes and their beliefs about health promoting foods. Participants perceived grains and animal products to have superior health promoting qualities. These selections were preceded by olive oil and to some extent by honey. Participants highlighted the importance of vegetables, however, many of the examples shared were focused on dishes with cooked vegetables. With low fruit consumption due to perceived high price confirmed by market survey showing a serving of fruit costing on average more than three times as much as a serving of vegetables and no importance given to raw vegetables, the adequacy of ascorbic acid in their diets appear poor.

Furthermore, considering that many of the male participants in the focus groups smoked cigarettes, the risk of inadequate vitamin C is further enhanced. In fact, the prevalence of smoking in the population (25%), which is considerably high among the male adult population (50%) (WHO, n.d.) in Tunisia increases oxidative stress in the body. Vitamin C reacts with the free radicals assisting in preventing damage to the DNA of mononuclear cells of smokers. Therefore, the recommended dietary allowance (RDA) for vitamin C is 20 to 80 mg per day higher than the amount recommended for nonsmokers in Canada, USA and a number of European countries (Carr & Lykkesfeldt, 2021). Nonetheless, the intake of vegetables and fruits according to an analysis of household surveys of adults in Tunisia over 10 survey rounds ending in 2015 indicated vegetable and fruit consumption per capita that is normally considered adequate (Doggui et al., 2020) with over twice as much the amount of sugar and sweeteners and over four times as much increase in the amount of meat consumed in 2015 compared to the amounts consumed in 1995. Meanwhile, the intake of vegetables and fruits among children and adolescents in Tunisia has been shown to be suboptimal (Delicado-Soria et al., 2021; Maatough et al., 2015). This is concerning in the face of increasing rates of obesity in the country. The rate of obesity among the focus group participants, 27% of women and 22% of men (total average 24%), appeared to be lower than the national rate of obesity among women at 37.5%, but similar to the rate of obesity among men at 22.1% in Tunisia (Global Nutrition Report, 2021).

When looking at multipronged interventions including community and school-based components that promote increased consumption of vegetables and fruits and increased engagement in physical activities, significant desired effect on body weight has been observed in the context of Tunisia (Maatoug et al., 2015). It should also be noted that a study of young Tunisian adults in university indicated

Working Document

the participants' desire to eat healthy and their dissatisfaction with the nutrition education they had received (Delicado-Soria et al., 2021). Hence, young adults can also be engaged and trained to promote healthy foods in their communities and households.

Another factor that appeared in all the focus groups was the influence of children on the food prepared in households. The role of mothers need to be understood in the context of collective cultures. Ristovski-Slipjepcevic and colleagues describe the role of mothers in collective cultures as caregivers, which was depicted in contrast to the role of mothers in individualist cultures as educators (2010). Framing sustainable dietary practices in households as a caregiving duty can be more practical than simply providing nutrition information. Training and psychological reframing of sustainable diets' concept and practical tips and recommendations regarding creative food recipes may help with caregivers' confidence in influencing children's dietary intake positively.

In regards to the effect of religion on dietary intake, the participants in focus groups did not acknowledge the direct effect of religion on their daily dietary habits. However, when asked specifically about how celebration of religious events related to food, participants readily listed all the special dishes and the meals they normally prepared for during the month of Ramadan, on Eid festivals, and on the birthday of the Prophet Muhammad, peace be upon him (PBUH). Interestingly, the list of healthy foods contained foods that have been recommended in the religious texts such as olive oil, honey, barley, figs and pomegranate. It is possible that such practice has become so integrated in the participants' lives that it is implemented without conscious remembrance of its connection to religion. Considering that the communities visited are relative to Tunis City more conservative, religiously framed messages related to sustainable diets' promotion may strengthen efforts in promoting sustainable diets.

A consistent finding from the conducted focus group discussions was the role children played in influencing the food prepared at home. School-aged children were in turn responsive to their teachers' demands to bring certain types of food to school. This highlights the importance of school food environment and the role teachers play in shaping children's food choices attitude and knowledge. Tunisia's school feeding program, such as home-grown type of school feeding program that connects local producers to the school food providers, currently covers 14% of the total student population (Global Child Nutrition Forum, 2022). Considering the current economic situation in Tunisia, it is unlikely that the program will grow to all rural or urban communities any time soon. Nutrition education resources, however, could be utilized if they meet the objectives of promoting good nutrition that would not support obesogenic diets. Sugar has been listed as a food modality (Global Child Nutrition Forum, 2022) among other foods in the school feeding program, which needs to be assessed in light of the findings from this study. Also, the program's objective is listed as "to meet nutritional goals" and not to reduce obesity. So it should be adjusted to allow appreciation for no-sugar-added type of food.

Recommendations

1. Since high grain consumption is prevalent and believed to be health promoting, options like biofortification and/or fortification of grain products can help alleviate prevalent micronutrient deficiencies can be targeted.

Recommendation: Align nutrition interventions with agricultural and food processing interventions.

Furthermore, the availability of whole grain products at the same price as highly processed products can help enhance nutritional value of products with the potential to prevent obesity.

Recommendation: Enhance the availability of whole grain products via processing and marketing and comparative price to highly processed grain products with less than 80% extraction volume at mills.

2. Vegetables are not prioritized making their consumption secondary to grains, olive oil and meat. Although cooked vegetables are incorporated in many dishes with generous use of tomato paste and roasted pepper, raw vegetable consumption was not mentioned. This can reduce intake of ascorbic acid (vitamin C) consequently losing the enhanced iron absorption activity of the heme and non-heme iron, which has been shown to be a concern for women in Tunisia (Dogui et al., 2020).

Recommendation: Intake of raw vegetables should be promoted.

3. High percentage of smokers and those exposed to second-hand smoking potentially increases the requirement for vitamin C.

Recommendation: An intervention integrating smoking cessation and reinvestment of the savings into vegetable and fruit consumption would be ideal.

4. Mothers' role as caregivers needs to be balanced against their role as educators of their children. Children's nutritional health should be emphasized to mothers as a caregiver responsibility.

Recommendation: Practical training on children's eating habits and ways of incorporating healthy food options should be provided.

5. Children's dietary habits should be the built around healthy foods:
 - a. Working with schools would be an effective way of reaching families with children and influencing children's food choices. School feeding

Working Document

program should exclude sugar-added food from the list of the foods served and switch to preventing obesity as its objective in areas with raising obesity rates as the program expands.

- b. Advertising of food with low nutritional value aimed at children should be banned.
- c. Healthcare providers can be trained to provide advice on nutrition to children and their caregivers. In fact, short consultations by healthcare providers in community clinics and hospitals can help initiate or reinforce nutrition messages. This has been seen in the context of opportunistic health behaviour change interventions (Keyworth et al., 2020) delivered by medical professionals to the general public in the literature and mentioned by a farmer in a focus group in the present study.

Recommendations: Engage with schools and community health care facilities to develop harmonized nutrition messages for targeted communities. Support advocacy efforts to ban advertising of unhealthy foods to children.

6. Explore religious framing of messages to promote sustainable diets in conservative rural areas in Tunisia. Utilize the communal food events as opportunities to normalize sustainable dietary practices.

Recommendation: Develop prototype intervention(s) with the participants to incorporate value-based practices in support of sustainable diets.

7. Knowledge and practice of easy to prepare nutritious foods that save time can be provided in training sessions across community venues including schools and cooperative sessions. Sustainable foods can be prepared in a communal setting to enhance acceptability and support in collective learning.

Recommendation: Provide hands-on cooking and communal food events where preparation and consumption of nutritious foods in possibly novel ways can be tested and disseminated.

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Annex I. Description of Tunisian foods perceived to be healthy by focus group participants

Food items that have a recipe are analyzed for their macronutrients. The tables include information about the ingredients for the recipes. Only major ingredients are analyzed, as they are the contributors to the calories per typical serving listed in the recipes sourced on the Internet. References are listed under each of the recipes in this annex and not placed in the References section of this report. The preparation methods are noted briefly. Most composite recipes were analyzed using NutriSurvey software open for non-commercial use (Erhardt, J. (2007). NutriSurvey for Windows. Accessed Feb 27, 2023. Available online at www.nutrisurvey.de). For single ingredients or ingredients that were not found in NutriSurvey software database, the USDA food data central and/or the Tunisian Food Composition Table (2007) was used.

Note that the calories listed for the product appears to be in disagreement with the calories provided by the sum of protein, carbohydrate, and fat. This can be due to calculation of carbohydrate amounts being by difference meaning small amounts of organic compounds are left in the quantity after calories, fats, proteins, and water are analyzed in laboratories (Compilers Toolbox, 2015).

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1. Assida Arabi

Description: Also known as Tunisian porridge, this dish is served for breakfast. It is made of wheat flour cooked in water and served with butter and honey.



Ingredients for 2 servings:

50 g	wheat semolina
100 g	water
15 ml	butter (estimated)
25 ml	honey

Preparation method:

Place the ingredients in a saucepan and heat over medium heat, stirring constantly.

Macronutrients	Amount per serving	% of calories
Carbohydrates	26.7 g	62%
Proteins	2.5 g	6%
Fats	6.4 g	32%
Fibre	1.8 g	
Calories	175 kcal	

Sources

Recipe: <https://www.kitchenstories.com/de/rezepte/assida-bidha-tunisienne-syd-byd-twnsy-35bc>

Photograph: Ahmadi, I. 27 August, 2014. Available online at <https://tittissemcaprices.blogspot.com/2014/08/assida-bidha-assida-blanche-tunisienne.html>

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2. Assida Zgugu

Description: Zgugu refers to Aleppo pine seeds. These seeds are collected from the wild, crushed and extracted by washing with water and passing the paste through a sieve. It is a special dessert like custard. It is decorated with nuts and seeds. The analysis excludes nuts and seeds as their amounts vary considerably. This is covered with a layer of custard or pudding made of flour, sugar, butter, and milk. This separate layer is not included in the nutritional analysis. The amount of servings is counted as 10 to compensate for the white pudding layer.



Ingredients for 15-20 servings in the original recipe (modified to 10 for nutrient analysis):

500 g of Zgougou paste

2.5 L of water

300 g flour

250 gr sugar (more or less depending on your sweetness preference)

Preparation method:

Zgugu is crushed and washed with water to obtain the seed extracts. Ingredients are mixed over medium heat and cooked like a pudding. They are served in small pudding cups and decorated with nuts and seeds.

Macronutrients	Amount per serving	% of calories
Carbohydrates	58.9 g	62%
Proteins	14.4 g	32%
Fats	22 g	6%
Fibre	1.2 g	
Calories	494 kcal	

Sources

Recipe: <https://carthagemagazine.com/assidat-zgougou-recipe/>

Photograph: Vie_sans_gluten. 15 October, 2021. Available online at https://www.youtube.com/watch?v=GKLVO_2Ywyo

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3. Barkookash

Barkookash, mhamsa and couscous are all generally wheat-based products made from semolina flour. The difference among these products is in their size with barkookash having the largest and couscous having the smallest particles. Unlike couscous, barkookash and mhamsa are added to soups with vegetables and meat. When barkookash and mhamsa are mentioned, the participants referred to the meal and not the grain by itself.



Macronutrients	Amount per serving	% of calories
Carbohydrates	58.9 g	62%
Proteins	14.4 g	32%
Fats	22 g	6%
Fibre	1.2 g	
Calories	494 kcal	

Ingredients (modified from original recipe to get 1 serving):

16.67g yellow onions	40g vine tomatoes
12.5g of carrot	5g fresh coriander
2g ras el hanout	Threads of saffron
1.5g of salt	0.5g paprika powder
0.33g black pepper	83.33g of meat
333.33ml of water	66.67g pearl couscous
0.17 beef stock cube	1 tbsp olive oil (estimated)

Preparation method:

Fry meat in oil then add blenderized vegetables and fry for two minutes, add the barkookash and water. Cook for 35 minutes. Let it stand for 10 minutes before serving.

Sources

Recipe: Ref: <https://kookmutsjes.com/recept/berkoukesh-mhamsa-parelcouscous/>

Photograph: Om Israa. 5 December 2021. Available online at <https://www.youtube.com/watch?v=9ml0AC84q3A>

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4. Bsissa

Bsissa is a well-known breakfast dish often consumed also in pre-dawn meal during the month of Ramadan by those who fast in Tunisia. There are different types of bsissa made with whole grains such as wheat, barley and sorghum, legumes such as chickpeas, fava beans and green lentils, nuts and seeds such as almonds and sesame seeds, and different spices and aromatic plants like cumin, coriander, rosemary, thyme and fennel.



Macronutrients	Amount per serving (60g)	% of calories
Carbohydrates (includes added sugar)	54 g	56%
Proteins	7.2 g	7%
Fats (includes added oil)	18 g	42%
Fibre	4.5 g	
Calories	388 kcal	

Ingredients (modified from original recipe to get 1 serving):

Since there are different types of bsissa with varying quantities of ingredients and prepared by adding olive oil and a sweetening agent like sugar or honey served in a bowl or make liquid by adding water and served as a drink, the nutrition information presented here comes from a ready-made product sold online.

Preparation method:

Add 15 g (about 1 tbsp) of olive oil and 1 tbsp of powdered sugar to 60 g of bsissa powder. Mix well. Honey can be used instead of sugar. Little water can be added to make a smooth paste. The small bowl of bsissa paste can be decorated with nuts.

Sources

Nutrition information: Bsissa. (n.d.). Visited 5 March 2023. Available online at <https://bsissa.fr/>

Photograph: Cuisine Tunisienne. (n.d.). Visited 5 March 2023. Available online at <https://www.cuisinetunisienne.tn/bsissa-tunisienne/>

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5. Couscous

Couscous is a wheat-based product, which in the marketplace is found in both low- and high-fibre versions. It has small granules that are cooked by steaming in a steamer. Couscous can also be made of corn, which is not as common as the wheat-based couscous. It is served with cooked meat, vegetables, and legumes stew. The whole dish is often called couscous or couscousi in Tunisia.



The composition of couscous does not contrast with that of pasta and the overall composition of the dish depends on the ingredients used. While meat is desirable for the stew served on couscous, vegetarian versions also exist with legumes like fava beans and chickpeas. The vegetables commonly cooked in the stew include carrots, pumpkin, zucchini, and potatoes among others.

The dish is served in a common platter from which consumers eat together or may portion out onto their plates ad lib.

Macronutrients	Amount per 100 g (dry couscous)	% of calories
Carbohydrates (includes added sugar)	74 g	85%
Proteins	13 g	15%
Fats (includes added oil)	1.5 g	4%
Fibre	3.85 g	
Calories	350 kcal	

Source

Nutrition information: Ministre de la Sante Publique. (2007). Table de Composition des Aliments Tunisiens. Last visited on Feb 28, 2023. Available online at https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers20-05/010041597.pdf

Photograph: Boss Kitchen. (n.d.). Visited 5 March 2023. Available online at <https://bosskitchen.com/tunisian-couscous/>

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6. Ghrayef

Ghrayef is like pancake made of soft dough, which is fermented by yeast and pan-baked. It is served with honey for breakfast.



Macronutrients	Amount per serving	% of calories
Carbohydrates (includes added sugar)	61.4 g	81%
Proteins	8.1 g	11%
Fats (includes added oil)	3 g	9%
Fibre	5.1 g	
Calories	308.8 kcal	

Ingredients (6 servings):

2 cups semolina
1 cup flour
3 cups warm water
1 tbsp sugar
1 tbsp yeast
1 tbsp baking powder

2 tsp honey (estimated per portion)
0.45ml sunflower oil (estimated per portion for cooking)

Preparation method:

Mix all the ingredients and let the dough rest for half an hour. Spread some oil onto a pan and roll out the liquid dough in a circular motion. Let bake on medium heat until bubbles are formed. Remove from pan without flipping the ghrayef. Drizzle honey on top (2 tsp per portion estimated and included in nutrition analysis).

Sources

Recipe: Nessma TV. Tunisian ghrayef with honey. (n.d.). Accessed 5 March 2023. Available online at <https://cuisine.nessma.tv/fr/recette/1665/cuisine-tunisienne/patisserie/ghrayef-tunisienne-au-miel>

Photograph: ibid

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7. Hlelam

This is a Tunisian soup made of white semolina, oil, flour and water, dried and cooked later as soup with vegetables and legumes. It is prepared and eaten in winter. No recipes for



Macronutrients	Amount per serving	% of calories
Carbohydrates (includes added sugar)	58.6g	47%
Proteins	27g	22%
Fats (includes added oil)	17.3 g	31%
Fibre	12 g	
Calories	503 kcal	

Ingredients (4 servings):

200g hlelam (vermicelli noodles used for analysis)
 200g meat cubed
 ½ cup chickpeas (handful quantity used in original recipe)
 ½ cup beans (handful quantity used in original recipe)
 1 onion
 sprigs of parsley and celery
 2 tbsp olive oil
 1 can tomato puree
 1 tbsp Harissa
 1 tbsp red pepper
 salt

Preparation method:

Slightly fry the chopped onion in olive oil. Add meat with all the other ingredients except hlelam, add water and cook. Add hlelam and cook for another 25 minutes. Serve hot.

Sources

Recipe: Nessma TV. Tunisian ghrayef with honey. (n.d.). Accessed 5 March 2023. Available online at <https://cuisine.nessma.tv/fr/recette/1403/cuisine-tunisienne/soupes/hlalem-tunisienne>

Photograph: ibid

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8. Khobbeeza

Khobbeeza refers to malva, also known as mallow, a plant whose leaves are cooked like many other leafy vegetables. It is spiced up with harissa paste and red pepper and is served as a side dish in Tunisia. It is commonly a foraged plant and not cultivated. Its use as a medicinal plant has been practiced in Mediterranean countries (Azab, 2017).



Its macronutrient content is not significant and thus not provided here. Its laxative effect can be related to its high fibre content (Azab, 2017).

Sources

Azab, A. (2017). Malva: Food, medicine and chemistry. *European Chemical Bulletin*, 6(7), 295-320.

Photograph:

Forage. (n.d.). Mallow: You've gotta try any plant that has a "cheese wheel".

Accessed 6 March 2023. Available online at

<https://www.foragesf.com/blog/2019/5/1/mallow-youve-gotta-try-any-plant-that-has-a-cheese-wheel>

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9. Malsoos

Malsoos is couscous that is made of barley instead of wheat. Just like coucous, it is served with meat, legume and vegetable stew. The grains are harder and coarser than couscous. It is soaked in water and steamed in a normal couscous steamer.

The nutrient composition for the dish depends on the ingredients used for the stew. Therefore, this is not presented here as it could be quite variable.



Source

Photograph: Fadhila. 22 Nov 2020. The traditional Tunisian malsoos. Accessed 6 March 2023. Available online at <https://www.youtube.com/watch?v=YaU5gY86OaU>

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10. Mbassis

Mbassis is unleavened pan-baked bread usually served with honey for breakfast.

The nutrient analysis does not include honey that would be used on top of the bread.



Macronutrients	Amount per serving (1 piece out of 10)	% of calories
Carbohydrates (includes added sugar)	40.5g	55%
Proteins	4.8 g	7%
Fats (includes added oil)	13 g	38%
Fibre	3.6 g	
Calories	299 kcal	

Ingredients (makes 10 servings):

500 g	medium semolina
4 tbsp	sugar
½ tsp	salt
100 ml	vegetable or olive oil (olive oil selected for analysis at 92.8g)
2 tbsp	butter (40 g)
100 ml	warm water

Preparation method:

Mix semolina, salt, sugar, and oil together. Add warm water to the mixture to form the dough. Spread the dough onto a flat surface by hand to about 1cm thickness. Cut into squares and pan-bake all the sides of the square over medium heat. Serve warm.

Sources

Recipes: Nesrine. (n.d.). Semolina sweet biscuits- Abraj/Mbasses. Accessed 6 March 2023. Available online at

<https://www.treatshomemade.com/en/recipes/abraj/>

Photograph: ibid

11. Mhamsa

Prepared like Barkookash (see #3. Barkookash) in a soup. The nutritional information is the same as in barkookash since both mhamsa and barkookash are made from semolina flour.

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12. Mermez

Mermez is a meat and legume based dish eaten with bread in Tunisia. The recipe here is the Tunisian mermez, which is different from the Moroccan mermez, which is fava-bean and green barley based soup.



Ingredients (makes 8 servings):

1 ¼ kg lamb shoulder,
 deboned and cut into pieces
 400 g dried chickpeas
 ½ tsp sodium
 bicarbonate
 3 tbsp tomato puree
 2 tbsp harissa (hot
 pepper puree)
 4 cloves garlic
 3 onions
 4 tbsp olive oil
 3 tsp mixed spices (Taboul is Tunisian spice blend including caraway,
 bumin, garlic and chili powder)
 2 green chilis
 to taste salt & pepper

Macronutrients	Amount per serving (1 piece out of 10)	% of calories
Carbohydrates (includes added sugar)	27.3 g	19%
Proteins	38.4 g	26%
Fats (includes added oil)	36.7 g	55%
Fibre	7.1 g	
Calories	593 kcal	

Preparation method:

Soak chickpeas for 12 hours with baking soda. Sauté onions in olive oil for 3 minutes in a pressure cooker. Add tomato puree and harissa followed by chickpeas and cook for 10 minutes after adding boiling water. Add pressed garlic and pepper and cook under pressure for 30 minutes. If meat and chickpea are not adequately soft, cook for an extra 10 minutes under pressure. Add cumin and paprika and cook for five minutes. Lastly, add salt and green chili and cook for 10 minutes covered.

Sources

Recipe and photograph: 196 Flavors 196 Countries. (n.d.). Accessed 10 March 2023. Available online at <https://www.196flavors.com/fr/tunisie-mermez/>

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13. Rayeb

Rayeb is fermented dairy product like yogurt. Thus the amount of macronutrients per serving of rayeb is the same as that of yogurt. Rayeb is not as thick as yogurt and consumed as a drink.



Macronutrients	Amount per serving (adjusted from 100g to 250g)	% of calories
Carbohydrates (includes added sugar)	7.75 g	22%
Proteins	6.25 g	18%
Fats (includes added oil)	6.25 g	40%
Calories	142.5 kcal	

Source

Nutrition information: Yogurt Nutrition. (17 August, 2020). What are rayeb, laban, labne, ayran & amasi? Accessed 5 March 2023. Available online at <https://www.yogurtinnutrition.com/what-are-rayeb-laban-labneh-ayran-amasi/>

Photograph: Wikipedia. 22 Feb 2023. Fermented milk. Accessed 5 March 2023. Available online at https://fr.wikipedia.org/wiki/Lait_ferment%C3%A9

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14. Rfeesa

This sweet dish is made for breakfast. It takes considerable amount of time to prepare as the dough is made by kneading for 10 minutes and left to rest for half an hour. After the bread is made it is crumled and soaked with a mixture that is prepared on its own.



Macronutrients	Amount per serving (1 out of 7)	% of calories
Carbohydrates (includes added sugar)	80.2g	57%
Proteins	8.8 g	6%
Fats (includes added oil)	24.1 g	37%
Fibre	7.6g	
Calories	576 kcal	

Ingredients (6 to 7 servings):

Bread base:

500 g medium semolina

2 tbsp olive oil

1 tsp salt

300 g warm water

50 g ghee or melted butter

Topping:

250 ml milk

6 tbsp sugar

100 g butter

200 g dates, pitted and chopped

Preparation method:

Mix the bread base ingredients and knead for 10 minutes. Cover the dough with wet cloth and let stand for half an hour. Divide into small pieces and roll out to ½ cm thickness. Cook both sides over medium heat in a pan. Crumble the bread in a bowl. Mix the topping ingredients and pour over this bread. Serve warm.

Sources

Recipe and photograph: Treats Homemade. (n.d.). Rfissa- crumbled bread with dates. Accessed 7 March 2023. Available online at

<https://www.treatshomemade.com/en/recipes/rfissa/>

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15. Taboona

This is a yeast-fermented bread baked traditionally in a terracotta oven. Kneading of the dough is the most important part of the preparation of this bread.



Macronutrients	Amount per serving (100 g)	% of calories
Carbohydrates (includes added sugar)	44.5 g	73%
Proteins	8.1 g	13%
Fats (includes added oil)	3.16 g	12%
Fibre	1.62 g	
Calories	244 kcal	

Sources

Nutrient information: Ministre de la Sante Publique. (2007). Table de Composition des Aliments Tunisiens. Last visited on Feb 28, 2023. Available online at https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers20-05/010041597.pdf

Photograph: Wikipedia. (n.d.). Tabouna bread. Accessed 7 March 2023. Available online at https://fr.wikipedia.org/wiki/Pain_tabouna

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16. Tajine

This dish is also served in restaurants and can be served in a sandwich. A special spice blend used for this dish is made with the following ingredients:

1 tsp each of cumin, coriander, turmeric and salt, ½ tsp each of paprika or cayenne pepper and black pepper, ¼ tsp each of caraway, thyme and cinnamon.



Macronutrients	Amount per serving (1 out of 12)	% of calories
Carbohydrates (includes added sugar)	7 g	15%
Proteins	16 g	35%
Fats (includes added oil)	10 g	49%
Fibre	1 g	
Calories	185 kcal	

Ingredients:

450 g chicken breast diced
 1 medium onion chopped
 1 large potato peeled and diced
 1 c water
 1 ½ c parsley chopped, loosely packed
 8 large eggs
 175 g mozzarella or emmental cheese shredded
 2 tbsp olive oil

Preparation method:

Saute the onions in 1 tbsp of olive oil over medium heat. Mix the chicken breast with half of the spice blend and add to the sautéed onions. Cook until brown. Add potato and water and cook uncovered until most of the liquid is evaporated. Remove from heat and add parsley. Whisk the eggs. Add the chicken, other half of the spice blend and cheese. Bake in an oiled baking pan at 180°C for 30 to 35 minutes. Cut into pieces and serve warm with harissa.

Sources

Recipe, nutrition information, and photograph: Diversivore. (n.d.). Tunisian tajine madnous. Baked egg, chicken, and parsley omelette. Accessed 7 March 2023. Available online at <https://www.diversivore.com/tunisian-tajine/#recipe>

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