

## Effects of food prices and consumer income on nutrient availability: An application of the demand for dairy products in Tunisia

Boubaker Dhehibi<sup>a</sup> and Abderraouf Laajimi<sup>b</sup>

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**SUMMARY:** Number of Tunisian food demand studies have measured the influence of traditional variables, such as income and prices, and in some cases some socio-demographic variables. However, given increasing concerns about health, other important factors, such as the nutritious quality and the nutrient content of food, have also been shown to determine consumer choices. This paper analyses the effect of these factors on the demand for dairy products. The nutritious quality of dairy products is measured by an index that relates nutrient content of each product with the standards suggested by the National Academy of Science. A demand system is estimated and nutrient demand elasticities with respect to prices and expenditure are obtained. Results differ from traditional studies in the sense that higher prices do not indicate lower consumption but a shift to a higher quality demand.

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**KEYWORDS:** Dairy products demand, health awareness, nutrients, price/quality index, Tunisia.

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**JEL classification:** D12, I12.

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### Efectos de los precios de los alimentos y de la renta del consumidor sobre la disponibilidad de los nutrientes: Aplicación a la demanda de productos lácteos en Túnez

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**RESUMEN:** La mayoría de la literatura sobre la demanda de alimentos en Túnez ha tratado de medir la influencia de variables tradicionales, renta y precios, así como la de algunas variables sociodemográficas. Sin embargo, hoy en día existen otros factores que pueden determinar la decisión del consumidor. Entre dichos factores destacan la calidad nutricional y el contenido nutritivo de los alimentos. Este trabajo analiza el efecto de estos factores sobre el comportamiento del consumidor de productos lácteos. La calidad nutritiva de los productos lácteos se ha medido a través de un índice que relaciona los aportes de nutrientes de cada producto en relación con los estándares sugeridos por la Academia Nacional de la Ciencia. Se ha estimado un sistema de demanda a partir del cual se han calculado las correspondientes elasticidades de los nutrientes. Los resultados tienden a contradecir los estudios anteriores en el sentido de que mayores precios no indican menor consumo sino una demanda de mayor calidad.

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**PALABRAS CLAVE:** Demanda de productos lácteos, preocupación por la salud, nutrientes, índices precio/calidad, Túnez.

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<sup>a</sup> Laboratoire de Recherches en Economie Rurale. Institut National de la Recherche Agronomique de Tunisie (INRAT).

<sup>b</sup> Département d'Economie, Gestion Agricole et Agro-alimentaire. Institut National Agronomique de Tunisie (INAT).

*Dirigir correspondencia a:* Abderraouf Laajimi. E-mail: raouf\_laajimi@yahoo.fr

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## 1. Introduction

The Tunisian dairy sector plays an important role both at the production level and at the consumption level. In fact the Tunisian government has given high priority to milk production in its agricultural plans to increase national production, to meet the rising demand for milk and to raise producers' income. The consumption of dairy products has increased and this evolution should continue at a high rhythm. Moreover, the dairy industry has been subject to important dynamics at the firm level, where multinational firms have entered into partnership with Tunisian companies.

Changes in consumer habits caused some shifts in the structure and the nature of the demand for dairy products. Thus, it is very important to have an accurate analysis of the demand structure of dairy products and to have estimates of how this demand reacts to changes in prices and income. Hence, enhanced knowledge about food products demand, in particular, dairy products, provides valuable information for producers, consumers, traders and policy makers. On the other hand, people are becoming increasingly health conscious, and health information can affect consumers' demand for milk and dairy products, since milk is largely considered as a healthy choice. Therefore, it is interesting to check whether some recommendations can be made about the types of dairy products to be consumed on a healthy basis.

In the Tunisian diet, dairy products enjoy a good image as revealed by their position in the food pyramid among the food products consumed daily. The diet plays an important role in determining the risk of chronic diseases such as coronary heart disease, cancer, diabetes, hypertension and osteoporosis as shown in the medical and human nutrition literature. As a consequence, food consumption patterns are increasingly being driven by a much more complex set of factors than economists have traditionally incorporated in demand studies. Some of these studies have already incorporated certain health information indexes to capture the effect of the increasing consumers' concerns about the potential health effects of food diet (Brown and Schrader, 1990; Capps and Schmits, 1991). However, few studies on dairy products' demand have been conducted in Tunisia. In general, they have addressed the sensitivity of demand with respect to prices and income.

Other studies have tended to take into account nutrient intakes. In this context, two main approaches have been used. The first one directly measures the effect of income and socio-demographic variables on the demand for nutrients (Nayga, 1994; Ramezani, 1995 and Dhehibi *et al.*, 2007). The second develops an indirect approach based on a two-step process. First, a food demand system is estimated in order to calculate the effects of relevant variables. Second, nutrient intake effects are obtained by applying nutrient conversion factors to the resulting food effects (Xiao and Taylor, 1995; Ramezani *et al.*, 1995; Huang, 1999a; Dhehibi and Laajimi, 2004).

Following Huang (1999b), the econometrically estimated demand structure for foods and the bundle of nutrient attributes in each food product is used to derive the implied relationship between the overall availability of nutrients and changes in food prices and income. Taking into account both approaches, the objective of this work is to improve our understanding about how economic factors affect dairy product choices in relation to the nutrient content of diets for Tunisian consumers.

To achieve our research goal, the paper is organized as follows. First, a brief description of dairy products consumption in Tunisia is offered. Section 3 outlines the theoretical foundation and the functional form of the model. Section 4 presents source and description of data. The discussion of the obtained results is provided in section 5. Finally, some concluding remarks are outlined.

## 2. Consumption of Dairy Products in Tunisia

The dairy sector in Tunisia is considered as strategic in the national agricultural policy and has undergone changes during the last years which have resulted in noticeable shifts in both production and consumption. In recent years many encouraging measures contributed to the boom of the dairy sector such as the subsidies program at producer level granted by the government in order to increase the production, where self sufficiency is almost achieved and quality becomes the key to more progress.

The demand for food in Tunisia has been subject to deep modifications during the last years following changes in the economic, social and cultural structure of the society. Demand is more diversified not only in terms of quantity but also in terms of quality. Several factors contributed to these changes: growth of disposable income, high urbanisation, media influence, diversification of food supply (local or imported), supply policy, efforts in nutritional education, etc. (Laajimi *et al.*, 2003). Moreover, advertising, concern about health and nutrition, changes in demographics, also affected consumption. Thus, the model of food consumption reveals an increasing share of animal products, in particular milk and dairy products where changes are more perceived.

In terms of calories, the increase in daily *per capita* intake over the last years reached an annual growth rate of 1.6% (2,278 kcal, in 1970 and 3,238 kcal, in 2002) according to National Statistics Institute (NSI) statistics. The share of calories from animal food products did not reach a substantial level and is still low (10.7% of total calorie intake). Indeed, meat consumption is primarily in the form of poultry followed by red meats such as lamb and beef, whose demand is deterred by relatively high prices. However, consumption of animal products recorded an increase during the 1975-2005 period. Expenditure share goes from 10.4% in 1975 to 13.1% in 2005, according to NSI data. Hence, as the market continues to expand, one might expect a potential for growth in the demand for dairy products as a whole.

Income changes have been often accompanied by changes in the structure and composition of food demand, with rapid urbanisation and income growth, a certain attraction has taken form for processed food, particularly processed dairy products (yoghurt, cheese), which are now widely consumed all over the country.

Consumer demand for dairy products in Tunisia has undergone changes over the last years. According to the statistics of NSI, in 1980 the average expenditure of milk was, at real price, 4.54 Tunisian Dinars (TD) per person and year. In 2000, this figure has risen to 30.4 TD per person and year. This trend is also observed for this food product when analyzing the structure of budget share with respect to total food products (Table 1). An increasing demand for milk and dairy products was associated

with an increase in their budget share going from 7.43% to 9.02% in total food products. Thus the prospects for dairy consumption remains positive indicating a growing market, especially for milk by products and high value products.

TABLE 1  
Evolution of the food expenditure on dairy products in Tunisia

Dairy products	Expenditure <i>per capita</i> (real prices in Tunisian Dinars *)					Budget Share (%) (with respect to total food products)				
	1980	1985	1990	1995	2000	1980	1985	1990	1995	2000
Milk	4.54	9.43	16.7	23.3	30.4	4.38	5.16	5.83	6.4	6.01
Yoghurt	1.98	2.96	4.50	5.53	8.22	1.91	1.62	1.57	1.52	1.62
Cheese	0.50	1.20	0.80	1.90	3.65	0.48	0.65	0.28	0.52	0.72
Butter	0.68	1.31	1.60	2.83	3.35	0.65	0.71	0.55	0.78	0.66
Total	7.70	14.9	23.6	33.6	45.6	7.43	8.16	8.42	9.22	9.02

Source: National Institute of Statistics (various years). Enquête nationale sur le budget, la consommation et le niveau de vie des ménages.

\* : 1 Tunisian Dinar = 0.5649 Euros.

Milk and dairy products' consumption in Tunisia has experienced several changes, not only in terms of expenditure as indicated above but also in terms of quantities (Table 2).

In general, per capita consumption of total dairy products followed an upward trend over the last two decades. Milk is a regular and important food staple for Tunisian households. It is consumed by persons of all ages and per capita consumption continues to increase. It increased from 67.1 kg/*per capita* in 1980 to 81.3 in 2000 and accounts for 9.02% of total food expenditure. Milk consumption per person grew during the last two decades. The average annual growth of *per capita* consumption for milk is 1.23% for the 1985-2000 period. For both cheese and butter, consumption showed a substantial increase (16.64% and 11.66%, respectively). Consumption of yoghurt registered a small decline in 1995, but increased thereafter at a 5% rate over the 1995-2000 period.

However, some variations are observed especially for yoghurt and cheese, whose consumption seems to be non-uniform and irregular. Fluctuations recorded between 1980 and 2000 are strongly correlated with variations in agricultural production, where difficult climatic conditions experienced led to significant drop of crop harvests.

To understand consumer's dairy products' demand behavior, a nutritional quality index is calculated assuming that food quality can be measured by nutritional content. In this context Hansen *et al.* (1979), developed an index of nutritional quality (INQ). It expresses the nutritional quality of a food item by comparing its nutrients with the calories' content. In order to compute the INQ, nutrients standards must first be determined. According to Hansen *et al.* (1979), a nutrient standard is the amount

TABLE 2  
Evolution of consumed quantities Consumption of dairy products in Tunisia (kg/capita/year)

	1985	1990	1995	2000	1985/2000 (%)
Milk	37.5	38.8	40.0	44.5	18.7
Yoghurt	29.0	33.0	28	35	20.7
Cheese	0.2	0.2	0.4	0.7	250
Butter	0.4	0.7	0.9	1.1	175

Source: National Institute of Statistics (various years), Enquête nationale sur le budget, la consommation et le niveau de vie des ménages.

of nutrient needed to meet a human's daily need in order to maintain good health. The Recommended Dietary Allowances (RDA) can serve as the standards<sup>1</sup>.

Based on the nutrient standard, the percentage of the standard of nutrient  $j$  in animal food product  $i$ ,  $W_{ij}$ , is calculated for each animal food product by:

$$W_{ij} = \frac{N_{ij}}{S_j} \cdot 100$$

$N_{ij}$  is the amount of nutrient  $j$  contained per unit of animal food product  $i$ , and  $S_j$  is the standard for nutrient  $j$ .

The INQ of nutrient  $j$  in animal food product  $i$  is expressed as the ratio of its percentage standard of nutrient  $j$ ,  $W_{ij}$ , relative to its percentage standard of energy (calories),  $W_{ie}$ . It is expressed as:

$$\text{INQ}_{ij} = \frac{W_{ij}}{W_{ie}}$$

For each nutrient in a dairy product food item, an INQ can be computed. It is of interest to remark that if the same dairy food product contained the same nutrients, there would be perfect multicollinearity among nutrients. So, from this approach the INQ for energy in any dairy product is one. The INQ's for other nutrients may be smaller or larger than one. For a desirable nutrient, a dairy food product having an INQ of 1.0 or greater for that nutrient is of good quality in the nutrient. Otherwise the dairy food product is of low nutritional quality. Results from such INQ's are given in Table 3.

<sup>1</sup> Recommended Dietary Allowances come from National Academy of Sciences (1989) and are: energy, 2,305 kcal.; protein, 46 gr.; total fats, 76.8 gr.; calcium, 0.6 mgr.; iron, 12.5 mgr.; magnesium, 314 mgr.; zinc, 13.5 mgr.; thiamine, 1 mg; riboflavin, 1.6 mg; niacin, 16.3 mg; folate, 167 mg; vitamin B12, 2 mg; vitamin A, 683 mg; vitamin D, 2.5 mg; y, vitamin B6, 2 mg.

TABLE 3  
Nutritional Quality Indexes of dairy products

Nutrients	Fresh Milk	Yoghurt	Butter	Cheese
Energy	1	1	1	1
Protein	2.54	3.05	0.04	3.62
Total fats	1.70	0.36	3.32	2,28
Calcium	7.15	8.43	0.076	5.44
Iron	0.28	0.22	0.05	0.28
Magnesium	1.35	1.52	0.0014	0.58
Zinc	0.78	1.24	–	0.84
Thiamin	1.41	1.40	–	0.17
Riboflavin	3.98	4.56	–	1.09
Niacin	1.74	2.07	–	1.56
Folate	1.06	0.33	–	0.63
Vitamin B12	5.31	–	–	2.62
Vitamin A	2.49	0.32	4.06	2.9

Source: Own elaboration.

Results from this Table show that, except for butter, all dairy products are of high quality in protein, calcium, iron, magnesium, thiamin, riboflavin and niacin. Among the different dairy products, fresh milk is of good nutritional quality in protein, total fats, magnesium, thiamin, riboflavin, niacin, folate and vitamins. In the case of butter and cheese, greater INQs for total fats imply that both products are of lower quality.

For desirable nutrients such as calcium and vitamins, fresh milk is considered of good quality in these nutrients assuming that the INQs vitamins are greater with respect to other dairy products. Otherwise, this product is of low nutritional quality with respect to zinc and iron. Butter is considered of good quality in vitamin A nutrient. Yoghurt is of high nutritional quality in total fats, calcium, riboflavin and niacin. Finally, cheese is of high quality in all nutrients except iron, magnesium, zinc, thiamin and folate.

### 3. Methodology and Theoretical Framework

As mentioned before the basic objective of this work is to improve our understanding about how economic factors affect dairy product choices in relation to the nutrient content of diet. In this context, the demand system developed by Huang (1999a) is used in this paper. A basic property of these demand systems with factors such as nutrients indicates that the change in a food price or income will affect all food items consumed and causes a wide variety of nutrients to change simultaneously. So, the information from a complete food demand system is needed to translate changes in food prices and consumer income into changes in the levels of nutrients availability.

As developed by Huang (1999a), the marshallian demand function can be represented by:

$$q_i = f_i(p, m) \quad [1]$$

$q_i$  denotes the demanded quantity of good  $i$ ;  $p$  represents the corresponding price vector; and  $m$  is the total expenditure. In differential form, the demand system of  $q$  commodities can be expressed as:

$$dq_i = \sum_j \left( \frac{\partial q_i}{\partial p_j} \right) dp_j + \left( \frac{\partial q_i}{\partial m} \right) dm \quad [2]$$

From (2), we obtain the following demand system:

$$\frac{dq_i}{q_i} = \sum_j e_{ij} \left( \frac{dp_j}{p_j} \right) + \eta_i \left( \frac{dm}{m} \right) \quad [3]$$

$e_{ij}$  is the direct and cross-price elasticities and  $\eta_i$  is the income elasticity.

The quantity of  $k^{\text{th}}$  nutrient available, say  $\phi_k$  as developed by Lancaster (1971), can be expressed as:

$$\phi_k = \sum_i a_{ki} q_i \quad (k = 1, \dots, K) \quad [4]$$

$a_{ki}$  is the quantity of the element  $k$  among all  $k$  nutrients obtained in a total of  $K$  nutrients obtained from a unit of the food item  $i$ .

Incorporating the expression mentioned above in [4] and taking into account the expression [2], we get:

$$d\phi_k = \sum_i a_{ki} \left[ \sum_j \left( \frac{\partial q_i}{\partial p_j} \right) dp_j + \left( \frac{\partial q_i}{\partial m} \right) dm \right] \quad [5]$$

Accordingly, the relative change in nutrient availability can be expressed as a function of the relative changes in food prices and *per capita* income as follows:

$$\begin{aligned} \frac{d\phi_k}{\phi_k} &= \sum_j \left( \sum_i e_{ij} a_{ki} \frac{q_i}{\phi_k} \right) \left( \frac{dp_j}{p_j} \right) + \left( \sum_i \eta_i a_{ki} \frac{q_i}{\phi_k} \right) \left( \frac{dm}{m} \right) \\ &= \sum_j \pi_{kj} \left( \frac{dp_j}{p_j} \right) + \rho_k \left( \frac{dm}{m} \right) \end{aligned} \quad [6]$$

$\pi_{kj}$  is a price elasticity measure relating the effect of a change in the  $j^{\text{th}}$  food price on the availability of the  $k^{\text{th}}$  nutrient, and  $\rho_k$  is an income elasticity measure relating the effect of a change in income on the availability of that nutrient.

From expression [6], we conclude that a major feature of this model is that it incorporates the information from a food demand equation including own and cross price elasticities ( $e_{ij}$ ) and income elasticities ( $\eta_i$ ) into the measurement of aggregate nutrient responses. Given the nutrient shares of individual food categories (CN) and food demand elasticities (EP) including a complete set of own and cross price elasticities, the matrix of nutrient demand elasticities (EN) is calculated as Huang (1999a):

$$EN = CN \times EP \quad [7]$$

$EN$  is a nutrient demand elasticities matrix of  $[K \times (n + 1)]$  dimension;  $CN$  is the nutrient shares of individual food categories matrix of  $[K \times n]$  dimension and  $EP$  is the food demand elasticities including a complete set of own and cross price elasticities matrix of  $[n \times (n + 1)]$  dimension.

From these nutrients' elasticity measurements, a change in a particular food price or *per capita* income will affect all food quantities demanded through the interdependent demand relationships and thus cause the levels of consumer nutrient availability to change simultaneously (Huang, 1999a).

#### 4. Data Sources

According to the procedure followed for estimating nutrient demand elasticities, two sets of input information are required: one is the matrix of food demand elasticities and the other is the matrix of nutrient shares of each food category: The information on food demand elasticities is obtained from the analysis of equation [3] for each food item. These demand equations were estimated using different data sources.

The annual consumption data and prices for fresh milk, butter and cheese are collected from the National Statistics Institute of Tunisia and from the Food Balance Sheet elaborated by the Food and Agricultural Organization (FAO). In order to obtain *per capita* data, population figures were collected from the same source. Annual consumer real price series for each commodity are found in the monthly statistical bulletin of Tunisia published by the NSI (National Institute of Statistics). Four dairy products are used in the analysis: 1) fresh milk; 2) yoghurt; 3) butter; and 4) cheese. The sample period covers yearly data from 1977 to 1999.

Secondly, to calculate the nutrient shares of each food category, data of average *per capita* consumption of dairy products and information on nutrient value of food per kilograms are needed. Information on nutrient values is compiled from USDA's Agricultural Handbook, used as an international reference, available online through the Internet system containing data on the nutrient content of the majority of food items. The nutrients used in the analysis are: 1) energy; 2) protein; 3) saturated fat; 4) calcium; 5) iron; 6) magnesium; 7) zinc; 8) thiamine; 9) riboflavin; 10) niacin; and 11) folate.



## 5. Results and Discussion

The demand equations corresponding to the four dairy products, as exposed in [6], were estimated by OLS. Since the model is specified in differentials, the series of variables are stationary. Moreover, the Durbin-Watson statistics indicates that residuals are uncorrelated. Most estimated parameters were statistically significant at the 5 percent significance level. Table 4 summarizes the estimated expenditure and own-price dairy products demand elasticities computed at sample mean.

TABLE 4  
Expenditure and own-price dairy products demand elasticities in Tunisia

	Budget Share (%)	Expenditure Elasticity	Own-price Elasticity
Fresh Milk	40.47	0.52**	-0.53**
Yoghurt	33.16	1.48**	-0.39**
Butter	9.36	0.81*	-0.54*
Cheese	16.99	0.70**	-0.028

Note: \* Indicates significance at 5%level; \*\* Indicates significance at 10% level.

Expenditure elasticities of fresh milk, butter and cheese are less than one, indicating that they can be considered as necessity goods in the Tunisian diet with respect to expenditure in dairy products. However, expenditure elasticity of yoghurt suggests that it can be considered as a luxury good. So an increase in dairy product expenditures induces more than proportional increases in the case of yoghurt, but less than proportional increases for fresh milk, butter and cheese. Own-price elasticities have the expected negative sign. The resulting demand for all products is inelastic. Among the four products, own price elasticity of fresh milk and butter are the largest in absolute terms. Yoghurt and cheese products are less inelastic. This result is argued by low consumption for Tunisia in both products.

Using previous elasticities and weight matrix, nutrient elasticities were derived (Tables 5 and 6). These elasticities show how the availability of 11 nutrients would change in response to change in four dairy food prices (fresh milk, yoghurt, butter and cheese) and income (dairy products expenditure). Expenditure nutrient elasticities represent the percentage change in the corresponding nutrient for a 1% change in dairy products expenditure. Own price nutrient elasticities measure the percentage change in the corresponding nutrient as a result of 1% change in prices.

In general an increase in dairy product expenditure produces an increase in the consumption of all nutrients under study. These results are plausible since all expenditure nutrient elasticities are positive. For example, the net effect of 1% increase in the dairy products expenditure would increase protein by 0.014%, energy by 0,29 and total fats by 0.016%, for fresh milk (Table 5). In terms of potential public concern about health effects, some significant estimates in Table 5 shows that an increase in

TABLE 5  
Expenditure nutrients elasticities

Nutrients	Fresh Milk	Yoghurt	Butter	Cheese
Energy	0.29*	0.315*	0.136*	0.040**
Protein	0.014**	0.019**	0.0001	0.0029
Total fats	0.016**	0.0038**	0.015**	0.0030
Calcium	0.542*	0.6931*	0.0027	0.057**
Iron	0.0004	0.00038	0.00003	0.00006
Magnesium	0.0538**	0.0654**	0.00002	0.0032**
Zinc	0.0013	0.0023	n.a	0.00019
Thiamin	0.00017	0.00051	n.a	0.000002
Riboflavin	0.0008	0.001	n.a	0.00003
Niacin	0.0035**	0.0046**	n.a	0.00044
Folate	0.022**	0.0077**	n.a	0.0018

Note: n.a.: not available (these nutrients are absent in the butter).

\*: Indicates significance at 5% level; \*\*: Indicates significance at 10% level.

Source: own elaboration.

daily *per capita* dairy products food energy (0.29 and 0.315 for fresh milk and yoghurt, respectively) would occur with a 1% increase in the budget share of fresh milk and yoghurt.

Likewise, the net effect of changes in dairy food consumption caused by 1% increase in prices is shown in Table 6. These results suggest that if prices were to increase, in a significant way, all nutrients available in fresh milk would decrease. For example, energy will be decreased by 0.29%, protein by 0.015% and calcium by 0.55%.

TABLE 6  
Own-price nutrients elasticities

Nutrients	Fresh Milk	Yoghurt	Butter	Cheese
Energy	-0.29*	-0.083*	-0.09*	-0.0016
Protein	-0.015**	-0.005	-0.00007	-0.00011
Total fats	-0.0169**	-0.001	-0.01**	-0.00012
Calcium	-0.55*	-0.18*	-0.0018	-0.0023
Iron	-0.0004	-0.0001	-0.00002	-0.000024
Magnesium	-0.0548**	-0.017**	-0.000018	-0.00013
Zinc	-0.0013	-0.0006	n.a	-0.000007
Thiamin	-0.00018	-0.00013	n.a	-0.00000012
Riboflavin	-0.0008	-0.00026	n.a	-0.0000001
Niacin	-0.0036	-0.0012	n.a	-0.000017
Folate	-0.0228	-0.002	n.a	-0.000074

Note: n.a.: not available (these nutrients are absent in the butter).

\*: Indicates significance at 5% level; \*\*: Indicates significance at 10% level.

Source: Own elaboration.

Because dairy product expenditure changes affect all nutrients in the same direction, those insufficient intakes of nutrients (calcium, iron and various vitamins) could be improved with increased dairy expenditure. Those already high intakes of nutrients (energy, total fats), would increase with increased dairy expenditure. Hence the net nutritional impact of increased consumer income is to be studied more closely as it may not be nutrient selective.

Lower consumption of certain nutrients is also a concern. Lack of minerals (calcium, iron, magnesium, zinc) or vitamins, for instance, hinders bone development. At the same time, concern about overbalanced diets stems from the health risks associated with excessive intake of saturated fat and bad cholesterol, which could lead to heart attacks. Hence, the new definition of food security must emphasize balanced diets rather than simply meeting energy protein requirements. In this context, calculated demand elasticities in the case of Tunisian consumers can help predict effects of food policies aimed at restructuring food diets.

## 5. Concluding Remarks

This study uses a methodology, developed by Huang (1999a), to measure how economic factors influence nutrient availability. The advantage of this model is that it converts information from food demand systems including price and income elasticities into nutrient responses. This methodology provides a translation of how changes in the availability of all nutrients vary in relation to food price and income changes. These results shed some light on the dietary consequences of possible changes in prices and income for dairy products. They are considered as part of the actual Tunisian diet and should be promoted for their significant contribution to the nutrient intake such as high quality protein and several key minerals and vitamins.

The estimate of expenditure-nutrient elasticities supports the conventional hypothesis that expenditure in dairy products growth can improve nutrient intake. Diversification of diets is found to be associated to increased income; therefore consumers would substitute less expensive source of nutrients with more expensive ones.

Policies aiming at reducing dairy products prices would assume an indirect increase of real income via the income effect and would enhance dairy products expenditure. Thus, policies that support consumption of dairy products should be maintained to improve nutrient intake. However, the growth in demand for these products may be constrained by the price increases of other food items.

In the context of access to food, the nutrient response estimates can offer important information for the knowledge of food demand structure which is a necessary step for the formulation of strategies and intervention policies in the food sector. This may be undertaken through studying food policy scenarios and examining the effects of possible changes of nutrients that are available for consumption. It is worth noting that a decrease in prices of dairy products is likely to have a positive influence on nutritional status of Tunisian consumers, but not to the same extent as increasing incomes.

Further collaboration between economists and nutritionists is useful for a better understanding when studying food demand and nutrition. Such analysis can be improved by incorporating households' socio-demographic characteristics and analyzing their influence on the availability of food nutrients.

## References

- Brown, D.J. and Schrader, L.E. (1990). "Cholesterol information and shell egg consumption". *American Journal of Agricultural Economics*, 72:548-555.
- Capps, O. Jr. and Schmits, J.D. (1991). "A recognition of health and nutrition factors in food demand analysis". *Western Journal of Agricultural Economics*, 16:21-35.
- Dhehibi, B. and Laajimi, A. (2004). "How economic factors influence the nutrient content of diet: An application of animal products demand system in Tunisia". *Agricultural Economics Review*, 5(2):67-79.
- Dhehibi, B., Gil, J.M. and Angulo, A. (2007). "Nutrient effects in consumer demand systems: evidence Evidence from panel data". *Acta Agriculturae Scandinavica C - Food Economics*, 4(2):89-102
- Hansen, G.R., Wyse, B.W. and Sorenson, A.W. (1979). *Nutritional Quality Index of Food*. Westport, CT: The AVI Publishing Company, Inc.
- Huang, K.S. (1999a). "Effects of food prices and consumer income on nutrient availability". *Applied Economics*, 31:367-380.
- Huang, K.S. (1999b). "Role of National Income and Prices". In Frazao, E. (ed.) *America's Eating Habits: Changes and Consequences*. USDA, ERS, *Agriculture Information Bulletin* No. 750:161-71.
- Institut National de la Statistique. (Several Years). *Bulletin Mensuel de Statistique*. Tunis, Ministère du Développement Economique et de la Coopération Internationale.
- Institut National de la Statistique. (Several Years). *Enquête Nationale sur le Budget et la Consommation des Ménages*. Tunis, Ministère du Développement Economique et de la Coopération Internationale.
- Laajimi, A., Dhehibi, B. and Gil, J.M. (2003). "The structure of food demand in Tunisia: A differential system approach". *Cahiers d'Economie et Sociologie Rurales*, 66:55-77.
- Lancaster, K. (1971). *Consumer Demand: A New Approach*. Columbia University Press, New York.
- National Academy of Sciences, National Research Council (1989). *Recommended Dietary Allowances*, 10<sup>th</sup> ed, Washington, D.C.: National Academy Press.
- Nayga, R.M. (1994). "Effects of socioeconomic and demographic factors on consumption of selected food nutrients". *Agricultural and Resource Economics Review*, 11:171-182.
- Ramezani, C.A. (1995). "Determinants of nutrient demand: A nonparametric analysis". *Journal of Agricultural and Resource Economics*, 20(1):165-177.
- Ramezani, C.A., Rose, D. and Murphy, S. (1995). "Aggregation, flexible forms, and estimation of food consumption parameters". *American Journal of Agricultural Economics*, 77(3):525-532.
- U.S. Department of Agriculture (1996). *Agricultural Research Service, Washington DC: USDA's Nutrient Data Base for Standard Reference Release 11 (SR11)*. The Online Version of *Agricultural Handbook* n.º 8. (<http://www.nal.usda.gov/fnic/foodcomp>).
- Xiao, Y. and Taylor, J.E. (1995). "The impact of income growth on farm household nutrient intake: A case study of a prosperous rural area in Northern China". *Economic Development and Cultural Change*, 43(4):805-819.