Demand and nutrients elasticities of camel meat: An analysis of kingdom of Saudi Arabia

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Abstract

This paper estimates demand elasticities for camel meat in Saudi Arabia (KSA) using the Linear Approximate Almost Ideal Demand System (LA-AIDS) model and the nonlinear AIDS model. The results show that the demand for camel meat is price inelastic. The income elasticity of demand for camel meat, based on the linear AIDS model, shows that camel meat is an inferior good, while the nonlinear AIDS model indicates that camel meat is a normal good. Furthermore, this paper estimates nutrients elasticity of meat in KSA by focusing on energy, protein, and fat. Compared to other meat products, the results show that energy and protein received from camel meat consumption are considered the least affected meat item in KSA by income and price changes. Fat received from camel meat consumption is more sensitive to prices and income changes compared to other meat items in KSA.

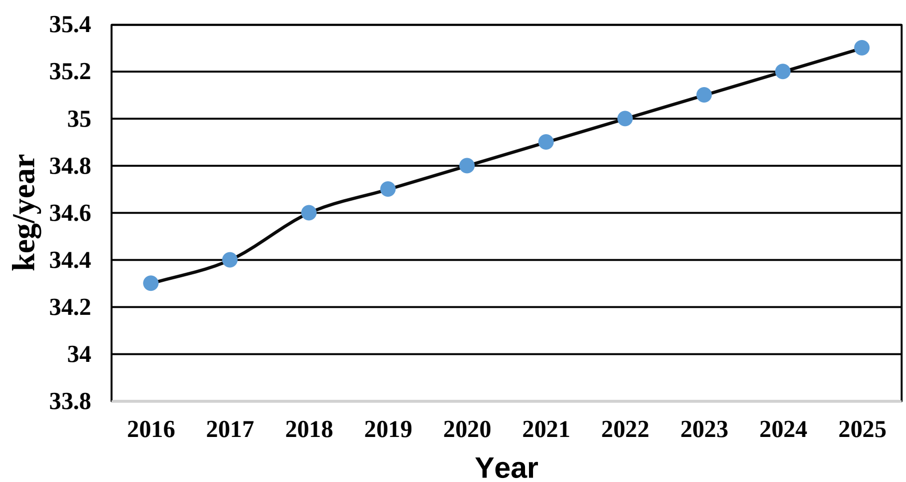
Keywords: Camel; meat demand; Almost Ideal Demand System; nutrients elasticities.

Introduction

World population is steadily increasing, and, in turn, there is a steady increase in food demand worldwide. In addition, various countries face acute food crises (UN, 2017). The world demand for meat has risen sharply not only due to increase in population, but also due to the improvement in technology, awareness of its nutritional value, and income increase (Ekine et al., 2012). OECD/ FAO (2016) report that growth in the demand for meat stems mostly from income and population growth. The expected annual meat production will need to rise by over 200 million tonnes to reach 470 million tonnes in 2050 (FAO, 2018). Animal meat production, specifically the red meats of camel, cattle, sheep, and goat are vital to human intake in all stages of life development. Meat consumption is particularly useful in case of iron deficiency, which is considered to be one of the most widespread nutritional problems in the world (ILRI, 2014). As it is clear in Fig. 1, the per capita consumption of the meat has steadily increased and is supposed to reach 35.3 kg/ year by 2025. Saudi Arabia (KSA) consumed a total of 50.8 kilograms of meat per capita in 2015.This is far greater than the global average, which amounts to 31.1 kilograms per capita in 2015 (EC, 2017). The per capita beef and sheep consumption in KSA ranged from 3.9–5.3 kilograms in 2017. However, per capita consumption of white meat was higher than the red meat, which is estimated as 44.7 kilograms in the same period (OECD/FAO, 2018). Kadim et al., (2012a) indicates that it is difficult to determine exactly the number of camels in the world. This is due to the fact that the owners of animal, nomadic people, and pastoralists, are moving frequently and camels are not usually subjected to obligatory vaccination. Moreover, camel meat production is probably underestimated because a significant number of camels are slaughtered out of official channels, so they were not included in the statistics (Kadim et al., 2012 b).

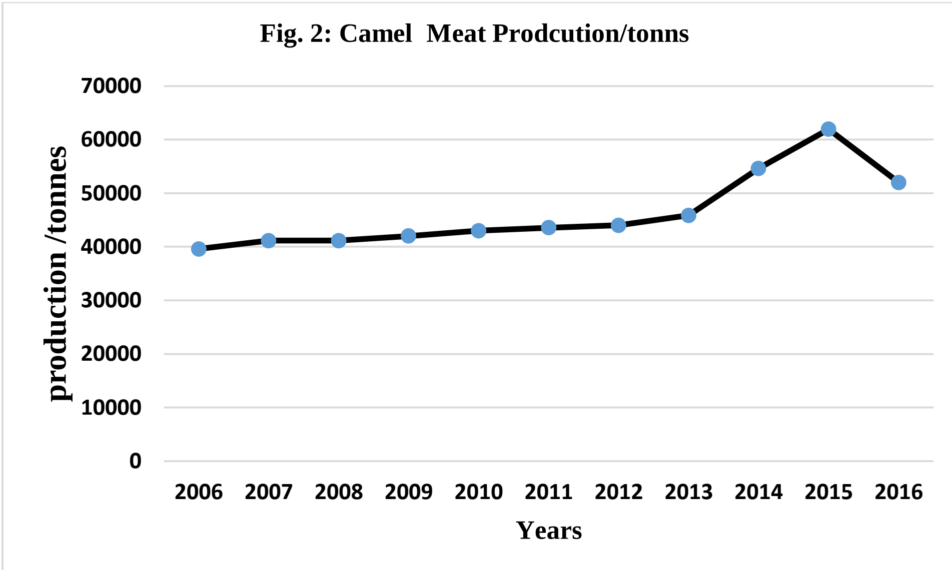
Camels in KSA are one of the most populated livestock species in the country. Approximately, more than 1,802,698 camels were living in KSA in 2015 (MEWA, 2015). However; these figures are probably undervalued since camels are migrant animals and are kept by the traditional producers. Three types of camel breeds are identified by General Authority for Statistics (2015) in KSA. The first is called “local bred,” the second is “foreign bred,” and the third is “crossbreed.” They represent 97.5%, 1.7% and 0.8% of the total camel population, respectively. KSA is the world’s largest importer of live camels. Australia is considered as the largest exporter of live camels in the world, and KSA is well-thought-of as the main importer of Australian camels (Clarke, 2014). Today, camels in KSA are used for economic and medical purposes. Economic usage of camels includes meat, leather, wool, oil and milk, while medical usage of camels are urine and milk, as mentioned in various studies (Al-Yousef et al., 2012; Hasson et al. 2015 and Kabbashi and Omer, 2016). Camels in KSA are considered to be a symbol of social prestige since one of the purposes of the camel import from Australia is mainly for ceremonial and beauty pageants (Clarke, 2014).

Fig. 1: World Per Capita Meat Consumption(Past and Projected)



Source: OECD/FAO (2016)

It is clear that from Fig. 2 that camel meat production has steadily increased during previous years and this is linked to the increasing meat demand. In 2016, the meat production dropped due to fears of some camel diseases associated with human health in KSA.



Source: FAO (2018)

KSA, just as other countries in the world, faces a high demand for red meat to fill the gap of increasing food demand. KSA is projected to be the largest country in the Arabia Gulf region for consumption of camel meat. During the last couple decades, there has been an increase in awareness of red meat produced from camels, but unfortunately, no adequate records were reported in relation to camel meat. This is maybe attributed to the production system practiced by camel producers, which is mainly practiced by nomads or traditional systems. Demand for camel meat is expected to grow in the future, according to numerous changes that have occurred, such as increase in national population and visitors, human habits, consumers preference for fresh meat from live camels, trade access, and increase in the awareness of the role of camel meat in health. The demand for camel meat appears to be increasing due to health reasons (Mahmud et al., 2010). Due to the fact that KSA is classified by the World Bank as a high-income country, increase in meat demand is predicted to rise, since the per capita income is high. Considering the importance of the topic, there are no studies of camel meat in terms of demand, supply, or processing. However, very limited studies were undertaken on the camel meat demand worldwide, in Arab countries in general, and KSA in particular, in terms of economic perspectives. The majority of the camel researchers who addressed the camel meat focused on the physiological and biological aspects, genetics, disease infections, characteristics of camel meat, and pollution related to camel meat production. They overlook the importance of camel meat from an economic point-of-view and the role of camel meat demand in enhancing the national economy (Ali et al., 2018; Wernery and Kaaden; 2002, Alharbi et al., 2011; Abouheif et. al, 1990; Abdallah and Faye, 2012, Mohammed et al., 2011). However, the majority of the world research on meat examines other livestock meat demand (Ekine et al., 2012; Aepli and Finger, 2013 and Juma et al., 2010).

Globally**,** various studies were conducted to analyse meat demand in the world. Mitsui Global Strategic Studies Institute (MGSSI) (2016) estimate meat demand globally by using each country's population and GDP forecasts. The MGSSI report (2016) confirms that global meat consumption will reach 388 million tonnes in 2030. This represents 1.44 times the 2011 figure. Also, it is predicted to reach 460 million tons in 2050, which represents 1.71 times the 2011 figure. Although its growth rate will slow down slightly, consumption of meat will continue to grow. MGSSI (2016) finds that there is a positive correlation between income and meat consumption. Similarly, Bett et al., (2012) confirms that the demand for meat is responsive to the allocated income. Furthermore, a global study implemented by Global Strategic Studies Institute (2016) expects that the growing demand for meat will push up the demand for feed grain. It is expected that about 40% of the world's wheat and corn is used for feed. These results confirmed that the meat demand is associated with feed demand increase. In addition, Clarke (2014) argues that there is strong demand to import camel from Australia for feeder and slaughter purposes. OECD/FAO (2018) report the global factors that affect and influence red meat demand. The factors are related to living standards, diet, livestock production, consumer prices, macroeconomic uncertainty, shocks to GDP associated with higher income, and a shift due to urbanisation to animal meat consumption as a source of protein in personal diets OECD/FAO (2018).

Numerous advanced and developed models to analyse meat demand are observed worldwide. Basarir (2013) uses the Linear Approximate Almost Ideal Demand System (LA-AIDS) to analyse consumer demand for meat in the UAE. He argues that the cross-price elasticity indicates that camel meat and beef are complements, while chicken and camel meat are substitutes. Sacli1 and Ozer (2017) use the AIDS model to estimate households demand for red meat in Turkey. The authors confirmed that when examining the cross-price elasticities for veal and beef, goat meat was found to be complementary good. A recent study performed by Zhang et al., (2018) uses the AIDS model. The authors tried to evaluate factors that affect households' meat purchases and to predict meat consumption changes in China. The authors also indicate that meat consumption patterns are affected by income changes. Karli and Bilgiç (2007) find that higher income households tend to demand more red meat than lower income household.

Some studies investigated the relationship between red meat demand and socioeconomic factors. A study by Chinda et al. (2015) in Nigeria, found that the socio-economic characteristics of household heads like age, household size, marital status, monthly income, and education affect demand and consumption of meat. Uzunöz and Karaka (2014) aim to determine the socio-economic factors affecting red meat consumption habits and consumer preferences of families in Turkey. They argue that the gender, education, household size, and income are significant and associated with red meat consumption. Mintert et al. (2009) examines beef demand in the US. Their findings show that consumer demand for beef is influenced by many traditional demand factors such as consumer expenditures and prices of beef and competing goods. Some researchers found that there are higher expenditure elasticities for meat (Abdulai and Aubert, 2005). In addition, Selvanatha et al., (2015) argue that the demand for all meat products and fish are price inelastic in KSA.

Bushara and Abdelmahmod (2016) attribute the high domestic demand of camel to the decline of camel exports. Bett et al., (2012) state that the availability of camel meat in some areas affects the demand of camel meat. This is due to the fact that in Kenya, camel meat is available to the pastoral communities, specifically those residing in the rural and urban centre. The demand for camel meat appears to be increasing due to health reasons since it contains less fat, as well as less cholesterol (Alamin et al., 2014). Camel meat in Pakistan is largely consumed by residents of rural and remote areas, since most of urban people have not developed the taste for it (Pasha et al., 2013). Some researchers consider the seasonal factors and their effect on the camel meat demand. Aujla and Hussain (2016) mention that the price of adult male camels remains comparatively high in winter season than in summer. Camel meat produced from young camels is tender and can be considered a healthy option (Kadim et al., 2014 a). This study aims to fill the gap of research on camel meat in economics literature by estimating demand elasticities of camel meat. Moreover, the study aims to estimate nutrients elasticity of camel meat in order to reveal the impact of price and income changes on nutrients intake resulting from camel meat consumption.

Methodology and data

Model

The almost ideal demand system was introduced in economics literature by Deaton and Muellbauer, (1980). It is abbreviated as AIDS, and it has been extensively applied to estimate demand elasticities for agricultural products. The model is specified as:

$$w_i = a_i + \sum_{j=1}^{5} \gamma_{ij} lnp_j + \beta_i \ln\left(\frac{y}{P}\right) + u_i$$

Where w_i is budget share for meat item i, p_j is price of meat item j, y is total expenditures on meat, P is a price index. The price index of the AIDS model is a translog price index defined as:

$$\ln P = a_0 + \sum_{i=1}^{5} a_i \ln p_i + 1/2 \sum_{i=1}^{5} \sum_{j=1}^{5} \gamma_{ij}\, lnp_i\, lnp_j$$

The model as described by the translog price index is known as nonlinear AIDS mode. The model has been linearized in the literature by using Stone price index defined as follows:

$$\ln P = \sum_{i=1}^{5} w_i lnp_i$$

The linear version is known in economic literature as the linear approximated AIDS (LA-AIDS). Eales and Unnevehr (1988) used the lagged share to calculate Stone price index. They attributed the use of lagged share to simultaneity problem. However, (Moschini, 1995) suggested other price indices such as Laspeyres, Paasche, *Törnqvist*, or geometrically weighted average price index.

In order to make the AIDS model consistent with micro theory, the model has to satisfy the following restrictions:
$\sum_{i=1}^{n} \beta_i = 0$ (Engle Aggregation)
$\sum_{j=1}^{n} \gamma_{ij} = 0$ (Homogeneity)
$\sum_{i=1}^{n} \gamma_{ij} = 0$ (Cournot)
$\gamma_{ij} = \gamma_{ji}$ (Symmetry)
The own-price elasticities and the cross-price elasticities for the AIDS model are computed as follow:
$e_{ii} = -1 + \frac{\gamma_{ii}}{w_i} - \beta_i$
$e_{ij} = \frac{\gamma_{ij} - w_j \beta_i}{w_i}$
Hicksian elasticities can be obtained using Slutsky equation as below:
$\delta_{ij} = e_{ij} + w_j \eta_i$
Furthermore, income elasticities are calculated as follow:
$\eta_i = \frac{\beta_i}{w_i} + 1$

Data

This study depends completely on secondary data. The data for fish, lamb, chicken, and beef is taken from Albalawi (2015) and Selvanathan et al. (2016), which are originally derived from the FAO and the Saudi Ministry of Environment, Water, and Agriculture. The camel data was obtained from the FAO Stat (2018). The data represents a time-series from 1991-2010. Quantity data is in kilogram per capita and prices are in Saudi Riyal. The FAO only reports camel prices per live head. We converted live camel price to price per kilogram by considering the fact that the average carcass weight of KSA's Najdi camel is 168 kilogram (Abouheif et al., 1986). Table 1 shows descriptive statistics of the Saudi consumers' budget shares on meat items.

Table 1. Descriptive statistics of budget shares

Budget share	Average	Standard Deviation	Minimum	Maximum
W_1	0.095	0.016	0.062	0.121
W_2	0.413	0.055	0.321	0.521
W_3	0.287	0.052	0.199	0.370
W_4	0.094	0.019	0.058	0.127
W_5	0.110	0.018	0.084	0.143

Note: W_1=Fish, W_2=Lamb, W_3=Chicken, W_4=Beef, W_5= Camel

On average, most of the Saudi consumers' budget on meat items is allocated on lamb, chicken, camel, fish, and beef; respectively. Thus, camel is ranked third in terms of budget expenditures. This is consistent with Abouheif et al., (1989), who found that camel meat is the third most preferred meat in Riyadh. Data on nutrients information for fish, lamb, chicken, and beef were obtained from the USDA Food Composition Databases. Nutrients information about camel meat were obtained from National Mission on Education through ICT.

Results and discussion

The nonlinear AIDS model and the LA-AIDS model were both estimated using iterative seemingly unrelated regression method (ITSUR). The lamb equation was dropped in the estimation to avoid singularity in the variance-covariance matrix. Furthermore, the parametric restrictions 1a − 1d were imposed in the estimation process. Table 2 shows the estimated parameters for the LA-AIDS model and Table 3 shows the estimated parameters for the nonlinear AIDS model. We corrected the autocorrelation in the nonlinear AIDS model using the method suggested by Berndt and Savin, (1975) and Seldon et al., (2000).

Table 2. Parameter estimate for the LA-AIDS model

Equation	Intercept	Fish	Lamb	Chicken	Beef	Camel	β	R^2
W_1	-0.592*** (0.1784)	-0.047 (0.0355)	0.005 (0.0442)	-0.055 (0.0365)	0.026 (0.0286)	0.071*** (0.0158)	0.142*** (0.0390)	0.71
W_3	-1.379* (0.6669)	-0.055 (0.0365)	0.039 (0.1463)	0.189 (0.1384)	-0.104* (0.0542)	-0.069* (0.0325)	0.483*** (0.1427)	0.55
W_4	0.092 (0.2596)	0.026 (0.0286)	-0.033 (0.0657)	-0.104* (0.0542)	0.001 (0.0642)	0.110*** (0.0243)	-0.049 (0.0570)	0.56
W_5	0.908*** (0.1660)	0.071*** (0.0158)	-0.146*** (0.0380)	-0.068* (0.0325)	0.110*** (0.0243)	0.034* (0.0184)	-0.219*** (0.0373)	0.76

Note: Standard errors are in parentheses. *, **, *** denote significance level at the ten, five, and one percent level.

Table 3. Parameter estimate for the nonlinear AIDS model

Equation	Intercept	Fish	Lamb	Chicken	Beef	Camel	β	R^2
W_1	0.264*** (0.0796)	-0.044 (0.0519)	0.008 (0.0497)	-0.006 (0.0306)	0.022 (0.0502)	0.021 (0.0307)	-0.052** (0.0234)	0.46
W_3	0.292*** (0.5120)	-0.006 (0.0306)	0.133 (0.0800)	0.064 (0.0573)	-0.092* (0.0461)	-0.099*** (0.0303)	0.013 (0.0185)	0.66
W_4	0.103 (0.0975)	0.022 (0.0502)	-0.069 (0.0707)	-0.092* (0.0461)	0.032 (0.0654)	0.107*** (0.0279)	-0.046* (0.0263)	0.55
W_5	0.171*** (0.0489)	0.021 (0.0307)	-0.065 (0.0421)	-0.099*** (0.0303)	0.107*** (0.0279)	0.036 (0.0255)	-0.045** (0.0172)	0.55

Note: Standard errors are in parentheses. *,**, *** denote significance level at the ten, five, and one percent level.

Table 2 and Table 3 report the single R^2 for each share equation. However, for the case of system of equations, the single R^2 is inappropriate (Bewley, Young, and Colman, 1987). The alternative R^2 for the case of system of equations is computed as follow:

$$R_L^2 = 1 - \frac{1}{1+LR/[T(n-1)]}$$

Where R_L^2 is the alternative R squared, LR is twice the difference between the log-likelihood of the model and the log-likelihood of the dependent variable regressed on the constant term only, T is the total number of observations, and n is the number of equations in the model. The computed R_L^2 for the linear AIDS model is 0.47. This shows that the linear model explains about 47% of the variations in the dependent variables. On the other hand, the R_L^2 for the nonlinear model is approximately 0.69. This shows that 69 percent of the variations in the dependent variables have been explained by the independent variables of the nonlinear model. Furthermore, Table 4 shows the estimated Marshallian elasticities of the LA-AIDS model and Table 5 shows the estimated Hicksian elasticities of the LA-AIDS model. In addition, Table 6 and Table 7 show the Marshallian and Hicksian elasticities of the nonlinear AIDS model.

Table 4. Marshallian elasticities of the linear AIDS model

Meat Item	Fish	Lamb	Chicken	Beef	Camel	Income Elasticity
Fish	-1.636*** (0.3884)	-0.561 (0.4209)	-1.003** (0.4394)	0.127 (0.2934)	0.579*** (0.1690)	2.493*** (0.4088)
Lamb	-0.003 (0.1054)	-0.984*** (0.2467)	0.043 (0.3272)	-0.095 (0.1634)	-0.373*** (0.0931)	1.176*** (0.2694)
Chicken	-0.351** (0.1502)	-0.348 (0.4594)	-0.825 (0.5681)	-0.522** (0.1837)	-0.426*** (0.1260)	2.686*** (0.4974)
Beef	0.320 (0.3209)	-0.133 (0.6793)	-0.955 (0.6819)	-0.938 (0.6607)	1.223*** (0.2811)	0.483 (0.6035)
Camel	0.833*** (0.1515)	-0.504 (0.3171)	-0.053 (0.3488)	1.186*** (0.2141)	-0.471** (0.1802)	-0.990** (0.3379)

Note: Standard errors are in parentheses. *,**, *** denote significance level at the ten, five, and one percent level.

Table 5. Hicksian elasticities of the linear AIDS model

Meat Item	Fish	Lamb	Chicken	Beef	Camel
Fish	-1.398*** (0.3723)	1.055* (0.4637)	0.424 (0.3823)	1.268*** (0.3003)	1.744*** (0.1657)
Lamb	1.012*** (0.1071)	-0.498** (0.1928)	1.094** (0.3543)	0.920*** (0.1590)	0.645*** (0.0920)
Chicken	0.808*** (0.1271)	1.135*** (0.5100)	-0.054 (0.4825)	0.636*** (0.1890)	0.760*** (0.1133)
Beef	1.271*** (0.3034)	0.653 (0.6958)	-0.103 (0.5746)	-0.893 (0.6804)	2.166*** (0.2577)
Camel	1.643*** (0.1432)	-0.326 (0.3445)	0.375 (0.2947)	1.998 (0.2206)	-0.581*** (0.1672)

Note: Standard errors are in parentheses. *,**, *** denote significance level at the ten, five, and one percent level.

Table 6. Marshallian elasticities of the nonlinear AIDS model

Meat Item	Fish	Lamb	Chicken	Beef	Camel	Income Elasticity
Fish	-1.416** (0.5432)	0.313 (0.5412)	0.095 (0.3076)	0.280 (0.5237)	0.276 (0.3351)	0.449* (0.2452)
Lamb	0.026 (0.1212)	-0.904*** (0.2300)	0.340 (0.2145)	-0.16118 (0.1699)	-0.151 (0.1039)	0.934*** (0.1262)
Chicken	-0.025 (0.1063)	0.450 (0.2919)	-0.790*** (0.1845)	-0.324* (0.1604)	-0.348*** (0.1054)	1.044*** (0.0646)
Beef	0.277 (0.5319)	-0.528 (0.7532)	-0.832 (0.4789)	-0.614 (0.6943)	1.190 (0.3084)	0.506* (0.2786)
Camel	0.226 (0.2738)	-0.422 (0.4017)	-0.776*** (0.2594)	1.011*** (0.2539)	-0.624** (0.2407)	0.586*** (0.1560)

Note: Standard errors are in parentheses. *, **, *** denote significance level at the ten, five, and one percent level.

Table 7. Hicksian elasticities of the nonlinear AIDS model

Meat Item	Fish	Lamb	Chicken	Beef	Camel
Fish	-1.373** (0.5445)	1.086* (0.5210)	0.937** (0.3204)	1.228** (0.5260)	1.216*** (0.3222)
Lamb	1.019*** (0.1203)	-0.518** (0.2274)	1.321*** (0.1938)	0.832*** (0.1712)	0.841*** (0.1019)
Chicken	0.979*** (0.1065)	1.463*** (0.2790)	-0.490** (0.1997)	0.679*** (0.1606)	0.655*** (0.1057)
Beef	1.230** (0.5314)	0.267 (0.7492)	0.026 (0.4883)	-0.566 (0.6929)	2.135*** (0.2959)
Camel	1.186*** (0.2786)	0.406 (0.3817)	0.105 (0.2749)	1.972*** (0.2532)	-0.559** (0.2315)

Note: Standard errors are in parentheses. *, **, *** denote significance level at the ten, five, and one percent level.

All the Marshallian and Hicksian own-price elasticities estimated from both the linear and the nonlinear AIDS model have the correct negative sign. This shows that the demand for meat in KSA is a downward sloping demand curve. Also, all the own-price elasticities are inelastic, except the own-price elasticity of fish. The Marshallian own-price elasticity of demand for camel is -0.471 and -0.624, according to the linear AIDS model and the nonlinear AIDS model, respectively. The results show that a one percent increase in camel meat price reduces the demand for camel meat by approximately 0.5 percent. The estimated Marshallian own-price elasticity of camel in the UAE is -0.695 (Basarir, 2013). Thus, our result is very close to Basarir's estimate. The Marshallian cross-price elasticities of demand based on the LA-AIDS model show that beef and fish are gross substitute to camel meat. Also, the Hicksian elasticities based on the LA-AIDS model show that fish is net substitute to camel meat. Furthermore, the nonlinear AIDS model shows chicken is the gross complement to camel meat and beef is net substitute to camel meat. The expenditure/income elasticities as reported in Tables 4 and 6, show some disagreement between the LA-AIDS estimates and the nonlinear AIDS estimates. The LA-AIDS model shows that camel meat is an inferior good while the nonlinear AIDS model shows that camel meat is a necessity good. The estimated income elasticities of the nonlinear AIDS model are inelastic, except for chicken. These results differ significantly from

Selvanathan et al., (2016) estimate. Their estimated income elasticities of beef, lamb, and fish were income elastic. Conversely, their income elasticity of chicken was income inelastic. The heterogeneity in the estimated income elasticities between our study and their study could be mainly attributed to adding camel meat in the estimation process and to using different empirical model.

Nutrients elasticities

Nutrients elasticities can help us evaluate the impact of income and price changes on nutrients intake. This can be done by utilizing income elasticity and price elasticity with respect to nutrients contents. In this paper we will focus on energy, protein, and fat. In other words, we will investigate the average effect of income and price changes on energy, protein, and fat intake resulting from meat consumption in KSA. The formula for calculating nutrients elasticities can be expressed following (Pitt, 1983; Sahn, 1988; Huang, 1996; Ecker and Qaim, 2011; Widarjono, 2012; Faharuddin et al., 2017):

$$\varepsilon_c = \frac{\sum_i \eta_i \propto_{ki} q_i}{\theta_k}$$

$$\varepsilon_{pj} = \frac{\sum_i \eta_i \propto_{ki} q_i}{\theta_k}$$

Where ε_c is the nutrient elasticity with respect income/expenditure, ε_{pj} is nutrient elasticity with respect to price, $\propto_{ki}$ is the amount of nutrient k received from consuming meat item i, q_i is the average consumed quantity of meat item i, and θ_k is the total amount of nutrients k received from total meat consumption. Table 8 shows nutrients elasticities estimated at the mean based on expenditure/income and price elasticities of the linear AIDS model. Additionally, Table 9 shows nutrient elasticities with respect to expenditure and price derived from the nonlinear AIDS model.

Table 8. Nutrient elasticities based on the linear AIDS model

Income	**Energy**	**Protein**	**Fat**	**Price**	**Energy**	**Protein**	**Fat**
Beef	0.033	0.034	0.002	Beef	-0.064	-0.067	-0.004
Chicken	1.585	1.634	0.242	Chicken	-0.487	-0.502	-0.074
Lamb	0.344	0.321	0.148	Lamb	-0.288	-0.268	-0.054
Fish	0.117	0.116	0.019	Fish	-0.077	-0.076	-0.013
Camel	-0.002	-0.001	-0.834	Camel	-0.001	-0.001	-0.397

Table 9. Nutrient elasticities based on the nonlinear AIDS model

Income	**Energy**	**Protein**	**Fat**	**Price**	**Energy**	**Protein**	**Fat**
Beef	0.035	0.036	0.002	Beef	-0.042	-0.044	-0.003
Chicken	0.616	0.635	0.094	Chicken	-0.466	-0.481	-0.071
Lamb	0.273	0.255	0.051	Lamb	-0.264	-0.246	-0.050
Fish	0.021	0.021	0.003	Fish	-0.066	-0.066	-0.011
Camel	0.001	0.001	0.494	Camel	-0.001	-0.001	-0.526

Based on the linear and the nonlinear AIDS model, energy and protein obtained from chicken consumption are the two most affected nutrients from any possible income changes. For example, a one percent increase in income increases the amount of energy and protein intake resulting from chicken consumption by almost 1.5 percent and 0.6 percent, based on LA-AIDS and nonlinear AIDS models, respectively. Table 8 and 9 generally show that the increase in meat prices have an adverse effect on the amount of nutrients obtained from various meat items. Furthermore, energy and protein received from lamb and chicken are the most affected meat item from price changes.

On the other hand, nutrients elasticities of energy and protein from camel meat consumption show that camel meat is the least affected meat in KSA by both price changes and income changes. For example, a one percent increase in the price of camel meat decreases energy and protein received from camel meat consumption by approximately 0.001 percent. Furthermore, nutrients elasticity of fat from camel meat consumption shows that camel meat is the most sensitive meat in KSA, regarding both price and income changes. A one percent increase in the price of camel meat results in a 0.5 percent reduction in fat obtained from camel meat consumption. Conversely, based on the nonlinear AIDS model, a one percent increase in income results in 0.5 percent increase in fat received from camel meat consumption.

This paper suggests future research to further examine demand for camel meat using micro data. This enables examination of the impact of socioeconomic characteristics on camel meat consumption and consumption patterns. The study also recommends to further examine camel meat demand in other countries with large camel populations.

Conclusion

This paper aims to accomplish two objectives. The first is to analyze and estimate demand elasticities of camel meat in KSA. The second objective is to estimate nutrient elasticities (energy, protein, and fat) of meat in KSA with respect to price and income. All the estimated Marshallian and Hicksian own-price elasticities were price inelastic, except the own-price elasticity of fish. The cross-price elasticities show that beef and fish are substitutes for camel meat. Moreover, the paper estimated nutrient elasticities of meat in KSA. The results generally show that energy and protein obtained from camel meat consumption are the least affected meat item by income and price changes. Furthermore, fat intake from camel meat consumption is the most responsive meat item to change in income and prices, compared to other meat items.

Conflict of interest

The authors declare that there is no conflict of interest in this paper.

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