

Nutritional profile and energy density evaluation of common traditional meals in Arabic Gulf region

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Abstract. – OBJECTIVE: This study aims to describe the energy and nutritional profile of common traditional meals in Arabic Gulf countries and extrapolate the usefulness of evaluating their energy density (ED) level.

MATERIALS AND METHODS: An analysis of 155 traditional meals commonly consumed in Arabic Gulf region was performed. The meals were categorized into four ED levels based on energy content as kcal per gram of meal weight. The meals were further classified according to their usual consumption pattern for the analysis.

RESULTS: The average percentage of macronutrient composition of the meals was 50% as carbohydrate (CHO), 18% as protein and 32% as fat. The majority of the meals were categorized as moderate energy density (MED) (55%) and about 38% of them were categorized as low energy density (LED), whereas less than 8% of the foods were categorized either as very low energy density (VLED) or high energy density (HED). ED value (kcal/g) for sweets (SW) was the highest (2.9 ± 1.3 , Mean \pm SD) compared to appetizers (APT) (1.9 ± 0.9), main dishes (MD) (1.7 ± 0.9), and side dishes (SD) (1.8 ± 0.9). A negative correlation ($p=0.000$) between moisture content and ED was found in all meal types. A significant positive correlation ($p<0.05$) was found between CHO content and ED of all meal types except MD. Protein and fat contents positively correlated with ED in all meal types.

CONCLUSIONS: The study illustrates that the number of HED meals among the common traditional meals in Arabian Gulf region is very limited. The data also suggest that common traditional meals in Arabic Gulf region can be part of a balanced diet to control energy intake if sweets consumption has been avoided.

Key Words:

Energy density, Obesity, Traditional food, Meal, Macronutrient composition, Gulf countries.

Introduction

Excessive energy intake, which results in positive energy balance, is linked to the increasing global prevalence of overweight and obesity^{1,2}. Increased energy intake is not only characterized by eating more food, in terms of the amount (portion size) consumed, but also can be through frequent consumption of high energy dense (HED) foods or meals³. The perception and comprehension of food energy density (ED) has been a key issue in terms of dietary intake and the establishment of a more balanced consumption behaviour⁴. ED of food, which is the energy released from a known quantity of food, has gained much scientific interest among nutrition scientists as a reliable measure of the overall quality of diet^{5,6}. ED can range from 0 to 9 kcal/g depending on the macronutrient composition of the food, and thus foods or meals can be categorized into different levels ranging from very low to high energy density^{3,7}. Traditional foods are an integral part of the diet and they have been developed a long time ago, and many of them are still part of people's diet⁸. Nutritional composition of foods or meals determines their impact on health, thus traditional foods may not necessarily be healthy or balanced nowadays considering modern lifestyle. Research^{9,10} indicates that diets or meals rich in fruits and vegetables, and foods containing significant amounts of water have low energy density (LED), whereas those rich in fats and sugars have high energy density (HED). Therefore, the use of ED level seems to be a simple and practical approach to control energy intake and indicate overall diet quality.

Increased body weight, particularly body fatness, is associated with increased risk for cardio-

vascular disease, stroke, diabetes and many other health complications¹¹⁻¹⁴. A number of studies^{9,10,15} have found a positive correlation between ED of consumed foods and obesity, with HED foods causing not only body weight gain but also the incidence of obesity-related cancers^{16,17} and other weight-related health complications^{10,15}. In addition, prior experimental trials¹⁸⁻²⁰ showed that consumption of LED foods while reducing frequency of HED foods consumption can be an effective approach for weight-loss and maintaining healthy body weight. Therefore, it is suggested^{21,22} that modulating food intake based on ED level could be an effective strategy for weight control and loss at population level and in clinical practice.

Obesity is a rapidly rising public health concern and its prevalence is estimated at 13% of the adult population worldwide²³. In the Eastern Mediterranean Region (EMR), a notable rise in obesity prevalence was reported^{24,25}, where 60% of the EMR countries had an obesity prevalence of 25% to 38% of the total population, which is much higher than the global average. Prevalence of obesity was reported²⁶⁻²⁸ to be a staggering 42% in Kuwait, 32.3% in the United Arab Emirates, 31.2% in Bahrain, and 28.3% in Oman. However, a reverse trend was observed^{29,30} in Saudi Arabia wherein the weighted prevalence of obesity decreased from 28.7% in 2013 to 24.7% in 2021. The decline in obesity prevalence was attributed to a number of programs initiated as part of the governmental vision 2030 plan, which includes the introduction of a 50% excise tax on sugary drinks, and a 100% tax on energy drinks starting from the year 2019³¹. Such programs were considered as substantial factor in reducing energy intake among individuals who frequently consume fizzy drinks and sweets as part of their dietary intake³²⁻³⁴. The observation that reducing consumption of energy dense foods can lead to a reduction in obesity prevalence prompted us to conduct a study aiming to evaluate the ED level of common traditional meals in Arabic Gulf countries and describe their energy and nutritional profile.

Materials and Methods

Study Design

This study is a secondary data analysis of 267 traditional meals, which are commonly consumed in Arabian Gulf region including Saudi Arabia, Bahrain, Kuwait, Qatar and Oman. Nations of

these countries share the same culture, religion, economic status, ethnicity, lifestyle and diet³⁵. Thus, for a data analysis purpose, meals with the same basic ingredients but with different recipe names, were averaged to a single value for each compound. Data on meals composition, including moisture, energy, fat, protein, carbohydrate (CHO), and fiber contents, were collected from established food tables³⁶ and 11 published studies³⁷⁻⁴⁸. Nutritional profiles of the meals were entered into Windiets[®] 2010 dietary analysis software (Robert Gordon University, Aberdeen, United Kingdom). The macronutrient content of the meals was entered as grams per 100 grams of meal weight, while caloric content was entered as kcal per 100 grams of each meal.

Meals Classification

Meals were classified according to their usual consumption pattern into the following categories: appetizers (APT), main dishes (MD), side dishes (SD) and sweets (SW)⁴⁹.

Energy Density Calculation

Energy density of the meals was calculated as kcal per gram of meal weight³. The resultant values were categorized into very low energy dense (VLED); yielding less than 0.6 kcal/g, low energy dense (LED); yielding 0.6 - 1.5 kcal/g, moderate energy dense (MED); yielding 1.5 - 4.0 kcal/g, and high energy dense (HED) foods; yielding more than 4.0 kcal/g of food^{3,7}.

Statistical Analysis

All statistical data analysis was carried out using SPSS Statistics v. 20.0 for Windows (IBM Corp., Armonk, NY, USA). Descriptive analysis using one-way ANOVA and Tukey's posthoc test were run to examine the differences within the groups and between all nutritional parameters. All the data were presented as mean \pm SD. Pearson's correlation test was used to establish positive or negative correlations between energy density and other variables. The p -value ≤ 0.05 was considered to be significant.

Results

Out of the two hundreds sixty-seven (267) meals, 21 beverages (=all beverages) were excluded from the analysis due to high variation in their recipes between the Arabic Gulf countries. In addition, energy and nutrient values of 91 meals,

which contained the same basic ingredients but had different recipe names, were averaged to a single value for each compound. Consequently, a hundred fifty-five (155) meals were included in the study analysis. These traditional meals are commonly consumed in Arabian Gulf region including Saudi Arabia (SA, n=100), Bahrain (BH, n=23), Kuwait (KW, n=20), Qatar (QR, n=7) and Oman (OM, n=5). The meals included 18 appetizers (APT), 74 main dishes (MD), 35 side dishes (SD) and 28 sweets (SW).

The average percentage of macronutrient composition of the included meals was 50% as CHO, 18% as protein and 32% as fat (Table I). The majority of the meals were categorized as MED (55%) and about 38% of them were categorized as LED (Figure 1).

It was observed that sweets contained significantly ($p<0.001$) lower moisture and significantly higher CHO ($p<0.001$), consequently resulting in the highest ED among other studied dish types (Table II). Sweets also contained significantly higher fat ($p<0.05$) and lower protein ($p<0.05$) compared to appetizers, main and side dishes. Among other meals, macronutrient contents were comparable except fiber content of the main dishes, which was significantly lower than other meal types ($p<0.05$). Subsequently, appetizers, main and side dish types were found to have higher percentage of meals with low and moderate ED. Appetizers and side dish types were the only groups that contained very low ED meals, while sweets

Table I. Average nutritional composition and energy density of traditional meals in Arabian Gulf region.

Average % Energy from CHO ¹	49.7 ± 23.4
Average % Energy from protein ¹	18 ± 12.5
Average % Energy from fat ¹	32.2 ± 17.2
Average % of moisture	59.6 ± 20.0
kcal per 100 g (ED)	1.95 ± 1.0

Values presented as means (standard deviation) and numbers of meals. ¹Average percentage of energy obtained from 100 grams of all included meals (N =155). ED, energy density.

and main dishes were the groups that contained high ED meals. Percentages and counts of meal types within ED categories are presented in Figure 2.

Furthermore, correlation studies revealed a highly significant ($p<0.001$) negative correlation between moisture content and ED of all meal types (Table III). On the other hand, a significant positive correlation ($p<0.05$) was found between CHO content and ED of all meal types. These relationships indicate that ED decreases with increasing moisture, while it increases with increasing CHO content of the meals. No statistically significant correlations were found between dietary fiber content and ED of any of the meals. In the case of protein and fat, an overall significant positive correlation ($p<0.05$) was observed, but inconsistency prevailed in side dishes wherein no such correlations were noted (Table III).

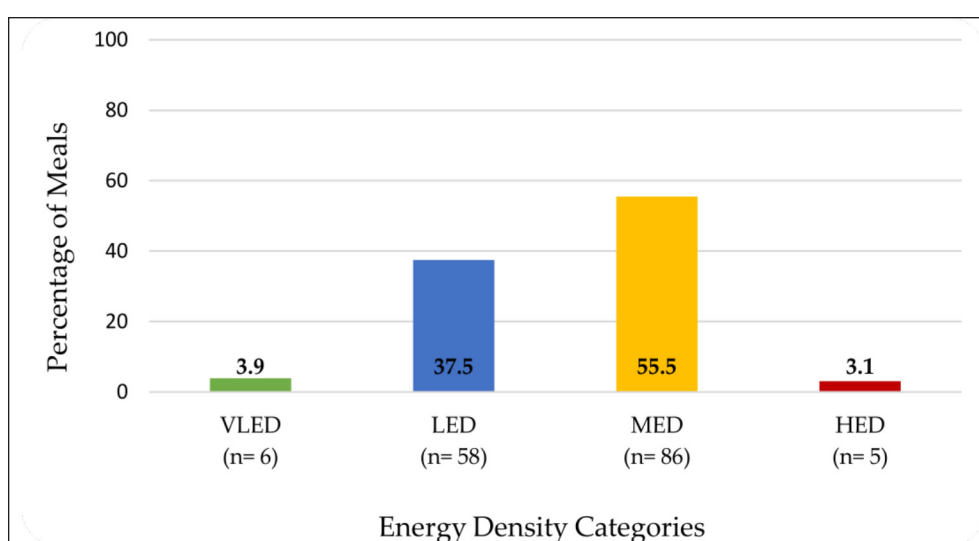


Figure 1. Number and percentages of meals within different energy density categories. VLED, very low energy density; LED, low energy density; MED, moderate energy density and HED, high energy density.

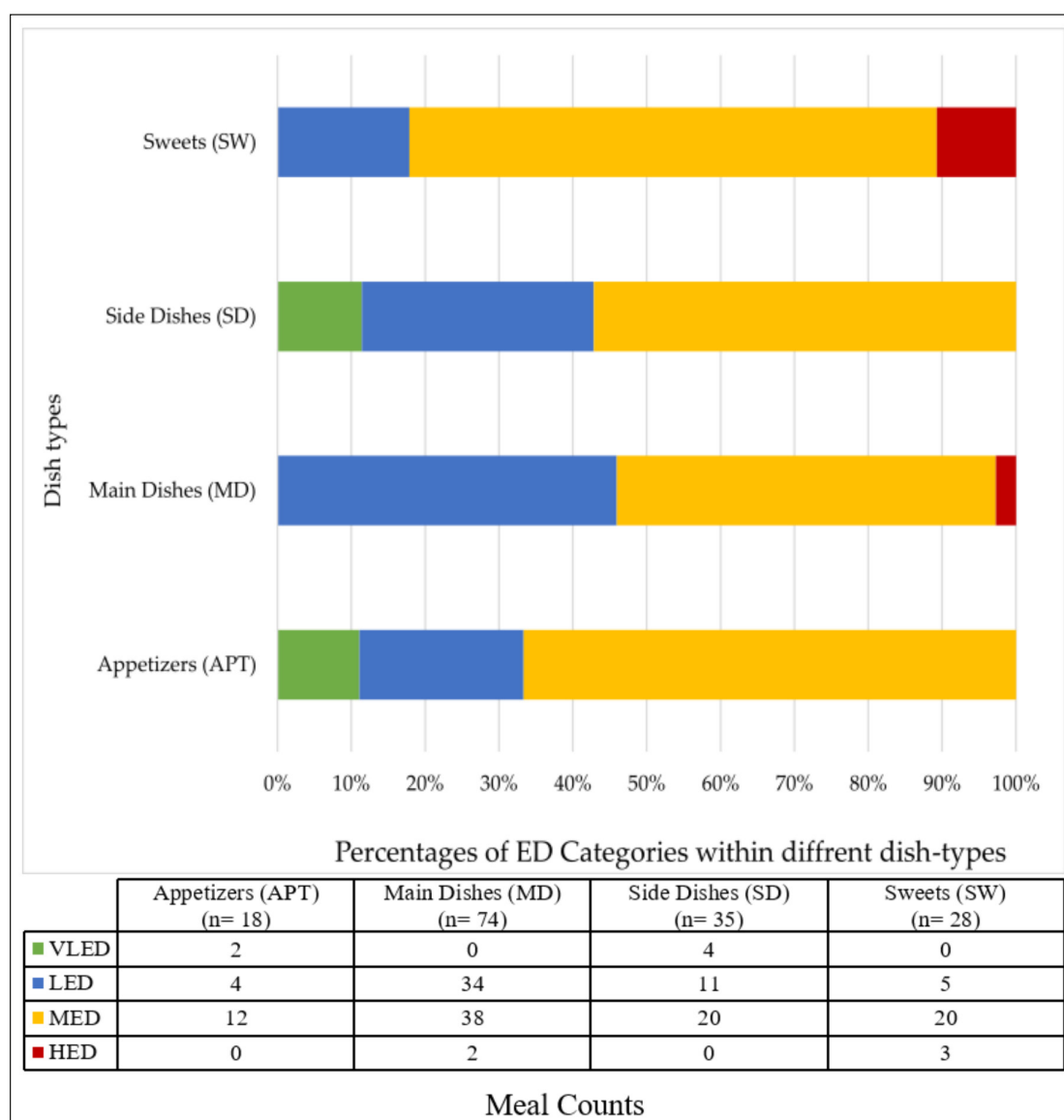


Figure 2. Percentages and counts of meal types within ED categories. ED, energy density; VLED, very low energy density; LED, low energy density; MED, moderate energy density and HED, high energy density.

Table II. General characteristics of the traditional meals as per dish type.

Parameter	Dish types			
	APT (n = 18)	MD (n = 74)	SD (n = 35)	SW (n = 28)
Moisture (g/100 g)	60.4 ± 18.0	66.4 ± 13.3	59.9 ± 22.2	40.8** ± 22.0
CHO (g/100 g)	21.1 ± 11.8	16.4 ± 10.8	25.7 ± 20.6	41.9** ± 18.1
Protein (g/100 g)	8.7 ± 4.7	9.1 ± 7.6	7.2 ± 5.3	5.6* ± 3.6
Fat (g/100 g)	7.6 ± 5.1	7.5 ± 9.2	5.6 ± 5.1	10.7* ± 7.3
Dietary fiber (g/100 g)	2.2 ± 1.5	0.6* ± 0.6	1.6 ± 1.4	1.0 ± 1.1
Energy Density (kcal/g)	1.9 ± 0.9	1.7 ± 0.9	1.8 ± 0.9	2.9** ± 1.3

Values presented as means (standard deviation) for normally-distributed data, *p*-values were calculated using One-way ANOVA **p*<0.05, ***p*<0.01 for value difference between dish types. APT, appetizer; MD, main dish; SD, side dish; SW, sweets.

Table III. Correlations between meal types and energy density, moisture and macronutrients¹.

Parameter	APT (n = 18)	MD (n = 74)	SD (n = 35)	SW (n = 28)	All (n = 155)
Moisture	-0.985 (0.000)**	-0.937 (0.000)**	-0.963 (0.000)**	-0.962 (0.000)**	-0.946 (0.000)**
CHO	0.803 (0.000)*	0.051 (0.663)	0.820 (0.000)*	0.760 (0.000)*	0.614 (0.000)*
Protein	0.742 (0.000)*	0.454 (0.000)*	0.405* (0.016)	0.468* (0.012)	0.319 (0.000)*
Fat	0.870 (0.000)*	0.922 (0.000)*	0.432 (0.010)*	0.771 (0.000)*	0.770 (0.000)*
Dietary fiber	0.240 (0.338)	-0.112 (0.343)	0.080 (0.649)	0.470 (0.12)	0.131 (0.104)

¹Data presented as correlation coefficients calculated between energy density and all other variables using Pearson's correlation test. * $p < 0.05$, ** $p < 0.01$ for value correlations presented with parenthesis. APT, appetizer; MD, main dish; SD, side dish; SW, sweets; All, all meals together.

Discussion

Findings of this study indicate that the majority of common traditional meals in Arabic Gulf region are categorized as MED or LED. Sweets were most energy dense meals in comparison to other dish types. These data suggest that, while avoiding sweets and HED meals, common traditional meals in Arabic Gulf region can be part of a balanced diet to control energy intake⁵⁰.

As expected, the present study showed a conclusive increase in ED of meals that contain higher CHO, fat and lower water content. Consequently, sweets predominantly containing grains and sugar syrup with high fat and low water exhibited higher ED compared to appetizers and side dishes that contained legumes, vegetables and meat along with grains. It is noteworthy, that the water content of the appetizers and side dishes was notably higher than sweets. These results are in good agreement with earlier studies^{51,52} wherein traditional Asian foods containing higher amount of water exhibited low ED. Furthermore, research⁵¹ indicates that food cooking or processing by boiling or steaming rather than frying primarily influences ED in Asian foods. Frying results in the exclusion of water, while boiling or steaming results in inclusion of more water without adding any energy⁵¹. It is also reported⁵³ that higher water content can lower ED even in high fat meals as it adds weight and volume to the meal without increasing energy content. The physical form of the food ingredient plays a role in lowering ED of foods or meals. As in the case of rice, which is the staple Asian food, it absorbs higher amounts of water and tends to be bulky thereby reducing ED of the meal^{51,52,54}.

The positive correlation between the fat content and ED found in this study was in line with the previous reports⁵² wherein, high-fat meals with low fiber and low moisture content exhibited high ED by yielding more calories per portion size. In this study, however, no correlation was observed between dietary fiber content and the ED of different meals. A similar observation⁵⁵ was earlier reported with respect to Indonesian traditional recipes. Careful analysis of the ingredients used in these traditional meals indicates that the combination of grains with legumes, meat and vegetables increases not only weight and volume of the meal, but also considerably lower ED thereby offering a good approach to lower the calories consumed per meal portion⁵⁶. This strategy of lowering ED is important because previous experiments^{3,56} indicated that incorporation of LED meals in the diet was helpful in controlling hunger as they promote satiety. Individuals can eat satisfying quantities of food that match their energy and nutrient demands if they adopt a lower-energy-dense eating habit, allowing them to avoid weight gain or decrease excess weight. Due to a variety of eating patterns that may be accommodated, a diet low in ED has broad applicability and can thus be an important component of a lifestyle that promotes a healthy, well-balanced diet for weight management³.

Conclusions

The data showed that common traditional meals in Arabic Gulf region have a strategic combination of cereal grains, meat, vegetables and legumes along with higher water content. This

allows individuals to eat satisfying quantities of food to match their energy and nutrient demands. The study findings also indicate that common traditional meals in Arabic Gulf region can be part of a balanced diet to control energy intake if consumption of sweets and HED meals has been avoided.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Ethics Approval

Not applicable.

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Informed Consent

Not applicable.

Availability of Data and Materials

The data used for the study can be accessed via the corresponding author.

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