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# Dietary Intake of Selected Common Vegetable Foods and their Total Carotenoids Determination

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**Abstract: Problem Statement:** Vitamin A Deficiency (VAD) remains widespread in many countries including Jordan, mainly due to inadequate dietary intake of vitamin A and carotenoids. **Approach:** Few researches on carotenoid content in vegetables and fruits are carried out. Thus, the aim of this study was to evaluate the dietary intake of selected common foods among a sample of adult Jordanians, by using Food Frequency Questionnaire (FFQ) and to analyze the carotenoid contents in selected vegetable foods by using UV spectrophotometry . **Results:** Among the total sample of 200 adults men and women, the consumption per person per week of rice was 21.1 serving, olive oil 20.9 serving, fresh carrot 13.6 serving, tomato 8.28 serving, mint 6.63 serving, chickpea 5.07 serving and parsley 5.03 serving. The total carotenoid contents were found in high concentrations in mint 25.2 mg 100 $g^{-1}$, parsley 21.8 mg 100$g^{-1}$, mallow 12.6 mg 100 $g^{-1}$ and carrot 8.79 mg 100$g^{-1}$. Zucchini, okra, tomato and green beans also contained appreciable amounts of carotenoids 3.38, 2.54, 2.19 and 1.97 mg 100 $g^{-1}$, respectively. Eggplant had the lowest content of carotenoids 0.48 mg 100$g^{-1}$. **Conclusions:** These finding could help the meal planning at a community level by including such high content of carotenoid vegetables in meals, which will lead to decrease the incidence of vitamin A deficiency disease. Further studies in this concern is highly recommended to solve such problem worldwide .

**Key words:** Dietary intake, carotenoids, vegetable foods, spectrophotometer, FFQ, vitamin A, Jordan

## INTRODUCTION

Consumption of vegetables provide the human diet with many essential nutrients like minerals and vitamins important for health maintenance. Vegetables also contain other food components, or phytochemicals, that provide benefits beyond normal health maintenance and nutrition. One important class of phytochemicals is the carotenoids. Carotenoids are lipid-soluble pigments found in all photosynthetic organisms. Among the naturally occurring plant pigments, carotenoids are widely distributed, with a high degree of structural diversity and large variation in biological functions. There are more than 600 carotenoids found in nature, with 40 dietary carotenoids regularly consumed in the human diet[1]. The carotenoids of fruit, vegetables and animal products are usually fat-soluble and are associated with lipid fractions. Due to the hydrophobic character, carotenoids are associated with lipid portions of human tissues, cells and membranes. They may also be esterifies or complexes with protein[2]. During proteolytic digestion, carotenoids are released from associated proteins and aggregate with other lipids. In humans, it has been reported that between 5 and 50% of carotenoids are absorbed. Absorption efficiency of carotenoids is known to be affected by the presence or absence of other carotenoids in the diet such as dietary fat and proteins[3] and by bile salts. The formation of micelles is a necessary precondition implicating the importance of dietary fat intake for the absorption of carotenoids[4]. As the amount of carotenoids in the diet increases, the absorption efficacy decreases[5]. Many factors influence the absorption and utilization of pro-vitamin A such as the amount, type, physical form of the carotenoids in the diet, intake of fat, vitamin E and fiber, protein and zinc status, existence of certain diseases and parasite infestation[6]. After absorption, pro-vitamin A carotenoids are cleaved in mucosal cells to form retinal, which is then reduced to retinol. Some unconverted carotenoids are directly absorbed and pass into blood where their composition reflects the diet[7,8].

Some specific dietary components increase or decrease the chances of disease occurrence in individuals. Thus, Knowledge of how many individuals have intakes more or less than a given criteria has relevance for planning health care for establishing theories on diet and health interrelationship[9]. Nutrition -related chronic diseases such as diabetes, cardiovascular disease, cancer and obesity have become epidemic worldwide and in Jordan[10]. A healthful diet

has long been considered essential in prevention, or reducing the risk of developing these diseases. Vegetables are a major source of carotenoids and because of their antioxidant properties, these compounds are thought to contribute to the beneficial effects of vegetable consumption[11].

Vitamin A Deficiency (VAD) remains widespread in many countries including the Eastern Mediterranean Region and global efforts are aimed at the virtual elimination of VAD and all of its consequences. Since inadequate dietary intake of vitamin A is the primary cause of VAD, the most rational approach for its prevention would be to encourage the daily consumption of adequate amounts of foods rich in vitamin A[12]. Eating 7-9 servings of fruit and vegetables per day as recommended by the current US Department of Agriculture dietary guidelines, may decrease the incidence of VAD in many countries .

Dietary improvement has been recognized as the major long-term solution to controlling VAD in a community. In those parts of the world where VAD is prevalent, vegetable products are the main source of dietary vitamin A in the form of carotenoids. Thus, horticultural and related activities to increase the availability of carotene-rich vegetable products have been emphasized. Carotenoid pigments, which are abundant in many fruits and vegetables have been studied for a number of years because of their diverse roles in photobiology, photochemistry and photomedicine[13-15].

In Jordan there are few researches on carotenoid content in vegetables and fruits. Vegetables are the second most important food group after cereals in the Jordanian diet. In order to carry out nutrition education activities to promote the consumption of carotene-rich products, more accurate data on the composition and content of carotenoids in these foods are required. In this study, we have measured the total carotenoids content in some vegetables that are grown, harvested and consumed widely by the Middle East population including Jordan.

## MATERIALS AND METHODS

The experimental work was carried out at carotenoids and Health Laboratory, Jean Mayer USDA Human Nutrition Research Center on Aging (HNRCA), Tufts University, Boston, USA.

**Dietary intake:** The dietary intake of selected common foods was determined by food frequency questionnaire among Jordanians. Data are expressed as serves per person per week. A serving of vegetable was defined as half a cup of cooked food or 1 cup of fresh food. A serving of olive oil was 5 mL.

**Collection of samples:** Samples of commonly consumed foods were collected from the local markets in Boston, USA. Replicate values of carotene content of these food samples were determined. All the necessary precautions were taken to avoid losses of carotenoids and other errors during analysis, e.g., working under red lights, finishing the analysis within the shortest possible time, exclusion of oxygen, avoiding high temperature and contact with acids, using high purity solvents, exhaustive extraction.

**Sample extraction and saponification:** Fresh sample of each food was extracted with acetone-methanol-petroleum ether (3:2:1, v/v/v) for 5 h in the dark, in order to avoid carotenoids degradation and oxidation at this stage. The crude extract was filtered, evaporated to dryness in a rotavapor and resuspended in ethyl ether. Saponification was carried out in ethereal solution by adding 30% w/v KOH in methanol to a final concentration of 10% w/v KOH. The mixture was stirred for 8 h (overnight) with magnetic stirring and carotenoids were extracted 5-6 times successively with ethyl ether from a saline solution to neutral pH. The soaps were eliminated by these procedures and the total carotenoid extract (TE) was evaporated on a rotavapor, brought to a fixed volume and used for quantitative evaluation of total carotenoids.

**Spectrophotometry of total carotenoids:** The extraction of the vegetable, using a procedure according to Briton *et al*.[16], was performed. The concentration of total carotenoids in TE was calculated by relating the absorbance reading A ($\lambda$ max = 450 nm) to the specific absorption (mean value $A_1^{1\ \%}$ =2500) of colored carotenoids:

$$x = (A.Y.\ 1000)\ (2500.\ 100) = A.Y/250$$

Where, x was the weight of carotenoids in the sample (mg) and Y was the volume of the sample (mL). The concentration of carotenoids was measured at 450 nm, in a Shimadzu UV-1700, pharmaspec spectrophotometer.

## RESULTS

Common English, Arabic and Scientific names of vegetable foods(mallow, rice, tomato, carrot, green beans, faba bean, chickpea, lentil, strawberry, okra, mint, parsley, zucchini and eggplant) included in this study are given in Table (1).

Table (2) shows dietary intake of selected food items by a sample of 200 adults residents in Jordan (100 men and 100 women) age 18-70 y. The consumption of mallow, okra, green beans and olive oil was approximately the same among men and women. Men consumption of rice, faba bean, chickpea and lentil was higher than women, while women consumption of tomato, carrot and dry beans was higher than men. Rice was the highest food consumed by the total sample with a mean consumption of 21.1 serving per week, while strawberry was the lowest food consumed with 0.08 serving per week. The consumption of okra was also low (0.48 serving per week).

The means of total carotenoid contents of raw vegetables are given in Table (3). Plants with the highest content of total carotenoids in decreasing order were mint 25.2 mg $100g^{-1}$, parsley 21.8 mg $100g^{-1}$, mallow 12.6 mg $100g^{-1}$, carrot 8.79 mg $100g^{-1}$, zucchini 3.38 mg $100g^{-1}$, okra 2.54 mg $100g^{-1}$, tomato 2.19 mg $100g^{-1}$ , green beans 1.97 mg $100g^{-1}$ and eggplant 0.48 mg $100g^{-1}$ .

Table 1: Common English, Arabic and scientific names of vegetables included in this study

| Common English Name | Arabic name | Scientific name |
|---|---|---|
| Mallow | Molokheya | *Corchorus olitorius* |
| Rice | Ruzz | *Oryza sativa* |
| Tomato | Bandora | *Lycopersicum esculentus* |
| Carrot | Jazar | *Daucus carota* L. |
| Green beans | Fasolia | *Phaseolus coccineus* |
| Faba bean | Foul | *Vicia faba* |
| Chickpea | Hummus | *Cicer arietinum* L. |
| Lentil | Adas | *Lens esculenta* |
| Strawberry | Farawlah | *Fragaria vesca* L. |
| Okra | Bamia | *Abelmoschus esculentus* |
| Mint | Nana | *Psidium cattleiianum* |
| Parsley | Bagdonis | *Petriselinum crispum* |
| Zucchini | Kussa | *Cucurbita pepo* |
| Eggplant | Bazinjan | *Solanum melongena* |

Table 2: Dietary intake of selected foods by a sample from Amman, Jordan by using food frequency questionnaire. Data are expressed as servings/person/week

| Food | Dietary Intake | | |
|---|---|---|---|
| | Men (n=100) | Women (n=100) | Total (Men & Women) (n=200) |
| Mallow | 1.26(0-4) | 1.28 (0-4) | 1.27 |
| Rice | 23.8(0-56) | 18.80 (0-42) | 21.10 |
| Tomato | 6.71(0-28) | 9.59(0-28) | 8.28 |
| Cocked carrot | 4.20(0-28) | 5.26(0-28) | 4.78 |
| Fresh carrot | 8.23(0-42) | 18.10(0-42) | 13.60 |
| Okra | 0.40(0-2) | 0.54(0-2) | 0.48 |
| Green beans | 1.44(0-4) | 1.46(0-14) | 1.45 |
| Dry beans | 1.01(0-4) | 1.58(0-14) | 1.32 |
| Faba bean | 2.16(0-7) | 1.23(0-7) | 1.65 |
| Chickpea | 5.69(0-28) | 4.54(0-21) | 5.07 |
| Lentil | 2.33(0-21) | 1.07(0-14) | 1.64 |
| Olive oil | 21.9(0-42) | 20.1(0-42) | 20.90 |
| Strawberry | 0.08(0-0.5) | 0.08(0-0.75) | 0.08 |
| Mint | 6.16(0-14) | 7.03(0-14) | 6.63 |
| Parsley | 4.73(0-14) | 5.28(0-7) | 5.03 |
| Zucchini | 4.62(0-8) | 2.64(0-6) | 3.54 |
| Eggplant | 1.32(0-6) | 0.83(0-6) | 1.06 |

Values are expressed as Mean (range)

Table 3: Total carotenoids content of commonly consumed vegetable foods

| Food | Total Carotenoids (mg $100\ g^{-1}$ )fresh weight |
|---|---|
| Mallow | 12.60 |
| Tomato | 2.19 |
| Carrot | 8.79 |
| Okra | 2.54 |
| Green beans | 1.97 |
| Mint | 25.20 |
| Parsley | 21.80 |
| Zucchini | 3.38 |
| Eggplant | 0.48 |

Values are mean (mg $100\ g^{-1}$) of duplicate determinations on fresh weight basis

## DISCUSSION

The values of total carotenoid contents of raw vegetables in this study ranged from 0.48 mg $100g^{-1}$ (eggplant) to 25.2 mg $100g^{-1}$ (mint) . Similar results were obtained by other studies[12,17,18].

Foods rich in an acyclic carotenoid, lycopene, one of the most abundant carotenoids in human blood and tissues, has been found to be associated with an inverse risk of both cervical cancer and prostate cancer. Green leafy vegetables contain both oxygenated and hydrocarbon carotenoids; yellow or orange vegetables have high amounts of α-carotene and β-carotene; tomatoes contain high amounts of lycopene. It is generally accepted that serum carotenoid concentrations mainly reflect the immediate dietary carotenoid intake. However, other factors such as sociodemographic characteristics, sex, season, smoking and alcohol drinking may also influence serum carotenoid concentrations[19].

Carotenoid accumulation in plant tissue appears to be shaped by the physiological, genetic and biochemical attributes of a plant species, as well as by environmental growth factors such as light, temperature and fertility. Significant differences in carotenoid accumulation among different vegetable crop species have been reported. The accumulation of carotenoid in plant foods is also influenced by environmental growing conditions. Carotenoid accumulations have been shown to increase and decrease in response to environmental manipulations, with different results for different plant species[1].

We have identified appreciable concentrations of carotenoid in vegetables commonly consumed as part of a Mediterranean diet. Various studies have shown a

significant correlation between habitual vegetable and fruit intake in plasma carotenoid concentrations. The use of olive oil in food preparation aids absorption of lipid-soluble compounds such as carotenoids, particularly those less polar, as well as being an important source of α-tocopherol in itself[11].

Diets evolve over time because of factors such as changes in food availability, food prices and level of income. Traditional, largely plant-based diets are being replaced by diets that are high in sugars and animal fats and low in starches, dietary fiber, fruits and vegetables. This transition, combined with a general trend towards a more sedentary lifestyle and a low level of physical activity, is an underlying factor in the risk of developing chronic diseases[20].

Considerable changes in food consumption patterns have occurred over the past 30 years in the Eastern Mediterranean Region (EMR). Analysis of the data collected from some countries on dietary consumption trends demonstrates a rapid rise in food energy availability and consumption, beyond requirement[21]. Data from the regional office for the Near East of the Food and Agriculture Organization of the United Nations, based on food balance sheets for certain Arab countries, indicate that the per capita food energy and protein availability has doubled and fat has increased three folds[21].

Food balance sheets/FAO, indicates that the average daily energy per person dietary energy supply in Jordan has been increased in 2004 and reached 3037 Kcal compared with 2679 Kcal $day^{-1}$ in 1996 and the consumption of fat was 87.1 g $day^{-1}$ and 75 g $day^{-1}$ in 2004 and 2003 respectively. Consumption of animal foods has been increased instead of plant foods associated with high intake of animal fat and cholesterol, which is considered a risk factors of cardiovascular diseases and some types of cancer[22].

## CONCLUSION

This study has identified rich sources of carotenoids, in commonly consumed Jordanian foods. The carotenoid contents of vegetables included in this study have been determined in several countries but the results are somewhat diverging. More data obtained by reliable methods are needed even for these vegetables in order to differentiate natural compositional variation from analytical variability. In view of the fact that the extent of deficiency, with respect to micronutrients like vitamin A deficiency, the foods included in this study contain a significant amount of total carotenoids and could be used in planning diets, which will prevent vitamin A deficiency. Although this study has identified new sources of provitamin precursors, which can be studied for nutritional effects, further studied for separation of carotenoids by modern methods, like HPLC are needed.

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