Evaluation of the nutritional value of couscous dish with emphasis on its lipid profile and quality

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Couscous is an ancient meal available almost anywhere in North Africa. It is well-known as a staple meal in Algeria, with several variations in terms of ethnic cuisine and preparation. For this study, we chose a standard couscous recipe that includes all the elements used in the making of a couscous-based dish (meat, vegetables, and legumes) in order to investigate the lipid profile, nutrient composition and define the adequate serving size for a complete couscous dish. This study focused on the lipid composition and lipid health indices of this popular dish as fat can contribute to the increase of nutrition related diseases, which have been prevailing lately. Our results showed that, a nutritionally adequate serving size of couscous providing 942 Kcal energy, contains 10.26 g of protein, 28.13 g of fat and 162 g of carbohydrates, is equal to 270 g. The fat content of the studied couscous was estimated to 10.42 per 100 g and was related to the amount of cooking oil used and also to the fat content of beef, which is the main ingredient of the couscous dish. The lipid profile showed that most of the fatty acids were polyunsaturated with moderate amounts of monounsaturated and saturated fatty acids. This reflected on the atherogenic and thrombogenic indices which were found to be low 0.556 and 07,67 respectively; this is due to the low saturated fatty acids that are the main contributors to atherogenicity and thrombogenicity, cholesterol was also low at 0.829 mg/100g. Couscous proved to be a good source of dietary fibres 52.11 g per serving. Vitamin B12 was not detected, but each vitamin B1, B3, B6, A and D was found in various amounts, 4.120; 3.286; 0.754; 0.189; 0.226 mcg/100g respectively. Beef and ghee might be at the origin of vitamin D which rarely occurs in food other than seafood. Although there are many variations in this popular dish, this study gives an overall idea of the nutritional value of similarly composed couscous-based dishes.

Keywords: Fat, Fatty acid profile, Cholesterol, Fat health indices, couscous.

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Received: October 1, 2022
Accepted: January 24, 2023

INTRODUCTION

Couscous is an ancient meal found almost anywhere in North Africa. It is well-known as a staple meal in Algeria, with several variations in terms of ethnic cuisine and preparation. Wheat flour and semolina are the main ingredients, with a lower amount of barley and corn added in a good amount [1]. A couscoussier is a traditional double-chambered food steamer used to cook couscous by North Africans (in Amazigh and Arabic cuisines) and nowadays by people all over the world. The steam-cooking pot is couscoussier in French, Taseksut in Amazighi, and Kaskas in Arabic [2, 3]. The origins of the word couscous are unknown. Some reckon it's onomatopoeic, a linguistic approximation of the hissing sound produced as steam goes through the holes in the pot. There are other theories as well, but no one can deny that the dish is of Berber origin. Even if everyone understands what is meant with couscous, it is usually eferred to with another name. Some Berbers

refer to it as sikuk; some as sksu in the Souss region, ta'am in Algeria, and kouski in Tunisia. There are also variations outside of the Maghreb [4]: Couscous can be prepared in various ways most of which contain a kind of protein (meat, chicken, or fish), beans (fava beans, chickpeas), and vegetables (onions, courgettes, tomatoes, carrots, etc), also; several types of fat can be used in couscous dish preparations like olive oil. The added fats are chosen based on their availability and consumption at family gatherings [4].

Fatty acid (FA) analysis is a quick and accurate way to determine the FA composition of fats and oils [5]. The FA catalogue is divided into three categories based on the number of double bonds: saturated FA (SFAs), monounsaturated FA (MUFA), and polyunsaturated FA (PUFA) [27]. The presence of SFA may have a negative impact on several factors related to cardiovascular disease (CVD) and atherosclerosis, with C14:0 and C16:0 fatty acids being among the most atherogenic, whereas C18:0 is thought to be neutral in terms of atherogenicity but thrombogenic [6], however; PUFA, particularly omega-6 (ω-6) and omega-3 (ω-3) FAs are proving indispensable in a properly maintained ratio for numerous beneficial health functions [7].

A large-scale prospective cohort study found that high cholesterol consumption was associated with increased mortality risk and CVD mortality or v. However, Pan et al. [8] found that dietary cholesterol consumption was not associated with dyslipidaemia or serum lipids. The degree of CVD risk varies depending on the type and level of dietary FAs [9, 10]. To avoid many health problems, various important nutritional indices are frequently used to describe the FA composition of foods and to evaluate their nutritional value. Index of atherogenicity (IA) and Index of Thrombogenicity (IT) are the most commonly used nutritional indices to determine lipid quality and FA composition because they outline significant implications and provide clear evidence [10].

Vitamins are families of extremely complex molecules that are organic in nature, present in food in small amounts, and necessary for a regular metabolism. A deficiency in vitamins may lead to complex diseases, but when these nutrients are replenished, the deficiency symptoms are resolved [11]. The prevalence of these deficiencies varies from one population to another for example studies targeting different groups of the Algerian population have shown that 40% of pregnant women were below the recommendations for Vitamin C, D, A, E, B1, B2, B3, B6, B9 and B12 [12].

Since the traditional making diagram of couscous has already been identified and how couscous based dishes, as described by Chemache et al. [3], are made, we have chosen a standard couscous recipe for this study that includes all the elements stated above in order to investigate the nutrient composition and define a nutritionally adequate serving size for a complete dish of couscous. Additionally, a focus was put on the lipid composition, as lipids contribute greatly to numerous nutrition-related diseases, as well as the lipid health indices of this popular dish, which are often used to analyse the FA content of meals, assess the nutritional value of FAs, and investigate their potential application in the treatment and prevention of diseases, this study also addresses some vitamins of the B complex, vitamin A and D, to give a more broad and complete image of the nutritional aspect of couscous.

MATERIALS AND METHODS

SAMPLE PREPARATION

The raw materials and ingredients were sourced and collected from local markets in Amman, Jordan, as they were available with the same specifications as in Algeria. The dish was prepared according to a local Algerian recipe including the ingredient quantities used, cooking time, and temperature.

The following procedure and ingredients were used to make the dish: 500 g of chopped beef was sautéed in the bottom part of the cooking pot in 30 g of ghee and 15 g of maize oil, 200 g of finely chopped onions, followed by 300 g of tomato puree, 30 g of tomato paste and 100 g of soaked chickpeas were added to the meat along with 1 teaspoon (± 4.2g) each of the following spices: paprika, turmeric, black pepper, ginger powder, Rass el Hanout. Salt to taste. 1000 ml of boiling water are added to the pot and the mixture is left to simmer for 2 hours on medium high heat. Within those 2 hours, 500 g of couscous gains are soaked in 250 g of water salted to taste and put in the upper part of the cooking pot to stem to 15 min the steaming process is repeated three times at the end of which 65 g of extra virgin olive oil is added to the couscous gains which are then set aside. At the 2h mark 150 g each of the following vegetables: carrots, courgettes and green beans were added and simmered for another 30 mins. Steamed couscous gains and the meat vegetable stew mixture are combined to make the complete dish. Each dish batch was homogenised after preparation and cooking and then divided into sub-samples prepared for the analysis and kept in airtight plastic containers in the freezer until the time of analysis at the Department of Nutrition and Food Technology Laboratory, The University of Jordan.

PROXIMATE ANALYSIS

Moisture, crude protein (N × 6.25), total lipid, crude fibre and ash contents were determined according to the standard procedures of AOAC [13]. Nitrogen Free Extract was obtained by difference (NFE = 100% - [protein+fat+ash+fibre%]). Energy values were calculated by multiplying carbohydrates, protein, and fat content by their respective energy conversion factors of 4, 4, and 9. Samples were analysed in triplicates.

FATTY ACID PROFILE ANALYSIS

Fatty acid methyl esters of the homogenised samples extracted fat were prepared according to the method described by Glass and Christopherson [14]. In summary, 100 mg of the extracted lipids were dissolved in 3 ml of hexane (Gas Chromatography grade) and 120 µl internal standard (i.e., nonadecane methyl ester) and 200 µl of 2N methanolic potassium hydroxide were added, and vortexed to reach a clear solution (approximately 1 min). A 200 µl of acetic acid was then added to the mixture and shook for 1 minute. The prepared methyl esters were analysed using capillary GLC column (Restek, Rtx-225, USA, cross-bond 90%-cyanopropylmethylpolysiloxane, 100 m, 0.25 µm) immediately after esterification by injection of 1µl of the hexane layer through the injection port of the GLC (model GC-2010, Shimadzu. Inc., Koyoto, Japan). The initial oven temperature was 165°C, held for 4 minutes, increased at a rate of 2°C/min to 180°C, increased at a rate of 5°C/min to 230°C, and then held for 6 minutes, for a total program time of 36 minutes. The injector temperature was 250°C, the FID temperature was 260°C, the flow rate was 1 ml/min Helium, and the split ratio used was 80. The fatty acids methyl esters (FAMEs) were identified using chromatogram of fatty acids standard.

CHOLESTEROL CONTENT DETERMINATION

Cholesterol determination was done after enzymatic hydrolysis and oxidation according to Trinder [15] using suitable ready kit R-Biopharm (Boehringer Mannheim- R-Biopharm, Germany (Cholesterol Colorimetric method for the determination of cholesterol in foodstuffs and other materials). The colorimetric indicator was lutidine-dye (3,5-diacetyl-1,4-dihydrolutidine) the formation of which was stoichiometric to the amount of cholesterol and was measured by the increase of light absorbance in the visible range at 405 nm. The spectrophotometer (Perkin-Elmer, Cleman Instruments Division 55-215) was set to Zero on the blank at 405 nm absorbance.

INDICES OF LIPID HEALTHY QUALITY

From the data collected on the fatty-acid composition, the Index of atherogenicity and Index of thrombogenicity were calculated according to Garaffo et al. [16] using the following formulas:

Index of atherogenicity (IA):

$$IA = [(4 \times C14{:}\,0) + C16{:}\,0 + C18{:}\,0] \,/\, [\Sigma PUFA + \Sigma PUFA - n6 + \Sigma PUFA - n3]$$

Index of thrombogenicity (IT):

$$IT = \frac{C14{:}0+C16{:}0+C18{:}0}{0.5\times MUFA+0.5\times PUFA\text{-}n6+3\times PUFA\text{-}n3/PUFA\text{-}n6}$$

VITAMIN ANALYSIS

The method described by Albawarshi et al. [16] was followed to determine water soluble vitamins in our samples. The concentrations of vitamins in the extracts were determined using Thermo Scientific DionexUltiMate® 3000 High-Performance Liquid Chromatography (HPLC) system consisting of a LPG 3400 SD pump, ACC- 3000 autosampler, and photo diode array detector (DAD). Reverse phase-HPLC with ACE C18-AR (250 × 4.6 mm; 5 µm) column was used. Gradient mobile phase consisted of 0.03% TFA in water (pH 2.6, B) and acetonitrile (A) was employed. The injection volume was 20 µl, the flow rate was 0.9 ml/min, and the column temperature was 25°C. The signal (peak area) of each vitamin was obtained using DAD at three wavelengths; 265 (B1, B3), 280 (B6), and 361(B12) nm.

The concentrations of A and D vitamins in the extracts were determined using methods described by Dionex [17]. The same HPLC device with a different Reverse phase-HPLC with Acclaim TM C8 120 Å and column (4.6 × 250 mm; 5 µm) was used. The mobile phase consisted of 98.5% methanol and 1.5% deionized water in isocratic elution. The injection volume was 20 µl, the flow rate was 1.0 ml/min and the column temperature was 25°C. The signal (peak area) of each vitamin was obtained using DAD at two wavelengths of 265 (D) and 325 (A) nm [18].

DETERMINATION OF PORTION SIZE

From the results obtained after proximate analysis the serving size for couscous was determined by equivalent of 10 g of protein per serving, was determined by calculation using Microsoft excel, then weighted using a kitchen scale and photographed for visual reference at a height of 0.54 meter from the sample and an angle of 45° with a camera quality of 24 megapixels [19].

STATYSTICAL ANALYSIS

All measurements were performed in triplicates and the mean values were declared. T test was performed using JMP (release 10, SAS institute, Cary, NC) was carried out to determine any significant differences between the fatty acids. Least significant difference (LSD) at a 5% level of probability was determined to separate differences in the proportions of fatty acids in the dish.

RESULTS AND DISCUSSION

PROXIMATE ANALYSIS

Results of the proximate analysis are shown in Table I. Fat content was found to be 10.42%; which was relative to the amount of cooking oil added and the fat rendered from the type of animal protein used (in this case beef). In terms of quantity, the dietary lipid intake will vary according to the many factors that influence energy intake, namely age, gender, height, and

Table I - Proximate composition (%) and Energy content (Kcal)* of couscous dish

Macronutrient	Values per 100 g
Fat (%)	10.42 ± 0.23
Protein (%)	3.80 ± 0.21
Fiber (%)	19.30 ± 0.36
Carbohydrates (%)	60.00 ± 0.76
Ash (%)	6.49 ± 0.01
Moisture (%)	74.06 ± 0.07
Energy (Kcal)	348.96 ± 0.05

*Values are means of triplicate determination ± SD (Standard deviation).

Table II - Fatty acid profile (g/100g total FA), lipid health indices and cholesterol content* of couscous dish

Component	Content (couscous)
SFA	28.595 ± 0.001
Myristic acid (C14:0)	3.988^{c} ± 0.001
Palmitic acid (C16:0)	15.068^{a} ± 0.001
Heptadecanoic Acid (C17:0)	0.442^{f} ± 0.0001
Stearic acid (C18:0)	7.250^{b} ± 0.001
Arachidic acid (C20:0)	0.629^{d} ± 0.001
Behenic acid (C22:0)	0.486^{e} ± 0.001
MUFA	28.652 ± 0.001
Palmitoleic acid (C16:1)	1.343^{b} ± 0.001
Margaric acid (C17:1)	0.198^{c} ± 0.001
PUFA	40.073 ± 0.00
Linoleic acid (C18:2)	39.763^{a} ± 0.00
γ-linolenic acid (C18:3)	0.730^{b} ± 0.00
IA	0.556 ± 0.01
IT	0.767 ± 0.01
Cholesterol (mg/100g)	0.829 ± 0.001

*Values are means of triplicate determination ± SD (Standard deviation).
SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids.
IA: Index of Atherogenicity, IT: Index of Thrombogenicity.
^{a,b,c} Means with different superscripts are significantly different ($P<0.05$).

weight. Dietary fat is digested more efficiently than dietary carbohydrate, according to findings from nutrient utilisation studies and epidemiological research. Weight-loss intervention studies, on the other hand, show that hypocaloric high-carbohydrate diets do not result in more weight loss than hypocaloric high-fat diets. Individuals wanting to maintain or reduce weight should focus on managing their calories [20].
When using the Dietary Reference Intakes (DRIs) for protein and the estimated energy requirements (EERs), the percentage of total energy required in the form of protein increases with age, is higher for women than men, and is higher for small compared to large adults at any age; it also depends on the total physical activity and thus energy intake [21].
When comparing the nutritional habits in Algeria among five other Mediterranean countries and also with the various official recommendations and the 'Mediterranean diet' as originally described. Karamanos et al. [22] found that protein contribution (%) to the energy intake varied very little, ranging from 13.4% in Greece to 18.5% in Italy - Rome. In the case of this dish of couscous, the contribution of protein in energy is very small as containing only 3.8 g/100 g.
The fibre content of our dish was very high, this adds consistence to the dish which produces a feeling of fullness, because fibres are resistant to digestion in the stomach, therefore, even though caloric intake may be similar, distention resulting from an increased fibre intake leads to a greater feeling of satiety [23]. Couscous contained 19.3 g fibre per 100 g, this amount covers approximately 90% of the DRIs and Adequate Intake (AI) which are set to 25 and 21 g/day, respectively. Evidence showed that recommended intakes of dietary fibre can provide prebiotics to the diet which lead to improvements in gut health, elimination of allergies, and prevention of infections [24].
Acceptable Macronutrient Distribution Range (AMDR) was set for total digestible carbohydrate based on the role of carbohydrates as a source of energy to maintain body weight. The AMDR for children and adults is 45% to 65% of total calories. The Recommended Daily Allowance (RDA) was set using a coefficient of variation of 15% [100 g/day + 2(15)] to yield an RDA of 130 g/day for children and adults [25]. Consequently, the quantity of carbohydrates will differ from one person to another. Although not exceeding the RDA, the amount of carbohydrates in our dish stays relatively high, with 60 g per 100 g. This might be problematic when crafting a meal plan for a diet as a portion of the calories will be covered by carbohydrates to the detriment of other macronutrients, although there is no counter-indication to high carbohydrate diets being used for weight loss and weight maintenance [26].
Moisture content was found to be 74.06% for couscous, this is due to the addition of a certain amount of water during the cooking process to achieve the desired consistency. Ash content is reflective of the mineral content and was found to be 6.49%.

FATTY ACID COMPOSITION, LIPID HEALTH INDICES, AND CHOLESTEROL CONTENT OF COUSCOUS

This study provided a nutritional evaluation of the FAs found in couscous and its health-related lipid indices, with focus on the FAs contributing in the calculation of the lipid health indices as well as the cholesterol content as shown in Table II. The analysis was made with T-test for a unique sample, the significance was found in all parameters ordered from the highest value "a" to the lowest.
Due to the combination of fats from both animal and vegetal origins used in the making of this dish, results showed diversity in the percentages of FAs. The examined dish contained moderate amounts of MUFAs. The PUFAs were predominant compared to MUFAs and SFAs.

The SFA found in the greatest quantity was palmitic acid (15.068 ± 0.001), followed by stearic acid (7.2507 ± 0.001), and myristic acid (3.988 ± 0.001). However, arachidic acid, behenic acid, and heptadecanoic acid were all present in low amounts. This is in accordance with the SFA composition found in beef as shown by Wood et al. and Daley et al. [27, 28]. This FA account raises cholesterol activity from beef and beef products, increasing cardiovascular illnesses as a result [29]. Palmitic acid, according to Musaiger et al. [30], is a major cholesterol-raising SFA in the diet. Stearic acid was also found in couscous, but it had no effect on total cholesterol or lipoprotein cholesterol levels in humans, also no atherogenic effect when consumed [31]. Replacing SFA with protein, especially plant protein, may reduce CVD risk [32].

As shown in Table II, the most abundant MUFA was oleic acid, this may be due to the use of a mix of maize oil and olive oil in the cooking process which abundantly contain oleic acid. This is in accordance with White et al. and López-Miranda et al. [33, 34]. Moreover, Alagawany et al. and Skřivan et al. [7, 35] reported that oleic acid was the most abundant FA found in olive oil and animal fat (i.e., beef meat).

Diets rich in MUFAs have been shown to decrease low-density lipoprotein (LDL) cholesterol and yield better lipid profiles. Normal subjects and type 2 diabetes patients have improved glucose metabolism. When MUFAs are used instead of CHO, the insulin demand and plasma glucose levels are both decreased. In normotensive and hypertensive patients, a 31% drop in systolic and diastolic blood pressure was seen after the implementation of a high MUFA diet [36].

As PUFAs accounted for more than 30% the FA composition in our dish, the most abundant was C18:2 (ω-6): linoleic acid. This might be due to the use of maize oil in the preparation of the dish; as it is the highest FA component of maize oil as stated by White et al. [33]. Additionally, this amount of omega 6 could be attributed to the high content of chickpeas with omega 6, which are used as an ingredient in couscous cooking [37]. Thereby, our dish may be considered a good source of PUFAs which contribute to the composition of all cell membranes, regulates cell signalling pathways, cellular activities, and gene expression by maintaining homeostasis for proper membrane protein activity and influencing membrane fluidity [38]. Consequently, the amount of omega 6 FAs was relatively high. The consumption of omega 6 rich diet has been linked to low-grade inflammation, oxidative stress, endothelial dysfunction, and atherosclerosis [39].

Nutritional indices are often used to analyse the FA content of meals, assess the nutritional value of FAs, and investigate their potential application in the treatment and prevention of disease. The IA indicates the relationship between the sum of the major SFAs and the major unsaturated FA classes [28]. The IT, which reveals a predisposition to produce clots in blood vessels, was created using IA by Chen and Liu [10]. The link between pro- and anti-thrombogenic (MUFA and PUFA) FAs is what is conveyed by this [40]. The main SFA favouring lipid adhesion to cells of the immunological and circulatory system are C14.0 and C16.0 which are considered pro-atherogenic and pro-thrombogenic, whereas C18:0 is thought to be neutral in terms of atherogenicity but thrombogenic [6].

The IA and IT were relatively low (0.556 ± 0.086 and 0.767 ± 0.078, respectively). Lower IA and IT levels imply better protection against coronary heart disease. IA values of 1.0 in the human diet are suggested from a nutritional standpoint [41]. In our dish, it did not exceed 0.6. This was possibly due to its high quantities of MUFAs and PUFAs, which are thought to be anti-atherogenic and anti-thrombogenic because they limit plaque aggregation and reduce levels of each esterified FA, cholesterol, and phospholipids, inhibiting the development of micro- and macro- coronary disorders [42]. Due to the fact that both IA and IT can be used to assess the potential impact of FA composition on cardiovascular health, consuming foods with FA compositions that have lower IA and IT offers superior nutritional value and may reduce the incidence of coronary heart disease. The suggested values from IA and IT, however, have not yet been provided by any organiation [43].

While a cholesterol RDI of 300 mg/day was recommended by Reiter-Brennan et al. [44], our couscous dish only contained 0.829 mg/100 g; which is negligible compared to the RDI. Exposing cholesterol to elevated temperature during cooking in the presence of MUFAs or PUFAs causes oxidation at variable degrees and hence, the higher the unsaturation degree of FAs, the higher the cholesterol oxidation thus leading to lower total cholesterol content [45, 46]. Dietary cholesterol is positively correlated to plasma cholesterol in some cases as there are high responsive and low responsive subjects [45, 47]. According to results of epidemiology studies, high plasma cholesterol level, especially high level of LDL, is directly associated with CVD [48]. Our results suggest that couscous present a low risk due to its negligible cholesterol content.

MICRONUTRIENTS

Thiamine or vitamin B1 retention is widely employed as an indicator of cooking losses in meat because thiamine is the nutrient most susceptible to thermal degradation and leaching from meat [49]. Since our dish was cooked in its broth without being discarded at the end, it was able to maintain a 4.12 mcg of vitamin B1.

Reportedly, thermal processing can also enhance the bioavailability of vitamin B6 (niacin) and carotenoids by releasing them from entrapment in the plant matrix [50]. This aligns with our results as we were able to

Table III – Vitamins concentrations (mg/100g) in couscous dish

	Vitamins					
	B1	**B3**	**B6**	**B12**	**A**	**D3**
Content (mg/100g)	4.120 ± 0.50	3.286 ± 0.06	0.754 ± 0.90	-	0.189 ± .20	0.226 ± 0.10

Values are means of triplicate determination ± SD (Standard deviation).

Table IV - Nutrition facts (contents of each fat, protein, fiber, carbohydrates, energy, saturated fatty acids, monounsaturated fatty acids, poly unsaturated fatty acids) for one serving of couscous (i.e., 270 g).

Nutrient	**Amount per serving**
Fat (g)	28.134
Protein (g)	10.260
Fiber (g)	52.110
Carbohydrates (g)	162.000
Energy (kcal)	942.000
SFA(mg)	8.040
MUFA(mg)	8.000
PUFA(mg)	11.300

SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids.

Figure 1 - Serving size for couscous (270 g).

detect the presence of vitamin B6, B3 and vitamin A although in low amounts (Tab. III). As illustrated in Table III, the amount of vitamin D detected in couscous was 0.226 mcg ± 0.125 per 100 g. Vitamin D is found in modest levels in beef mostly in the form of vitamin D3 and its metabolite 25(OH)D3 [51] Ghee also contains a small amount of vitamin D estimated at 0.326 mcg/100g [52]. The presence of vitamin D in our final dish may be due to the use of these two ingredients. Vitamin B12 on the other hand was not detected, this was probably due to thermal processing.

For the sake of the experiment, the prepared samples were stored in the freezer compartment of a refrigerator (as mentioned in the materials and methods section). Freezer compartments of refrigerators generally do not allow for temperature below – 18°C to be reached. Fluctuations in the freezing temperature might be responsible for the significant losses of vitamins in meats and lower losses in vegetables [53]. Our results show that couscous can contribute to the intake of some vitamins of the B complex along with vitamin A and D

SERVING SIZE

Dietitians use the notion of portions to assess the calories and macronutrient content of food taken in practice [54]. A serving is a standard measure of food with known calorie and macronutrient composition, whereas a serving size is a comparable measure of food. A serving of cooked rice, for example, has about 15 grams of carbohydrate, 3 grams of protein, and 1 gram of fat, for a total of 80 calories [48, 55]. Half cup is the measure of cooked rice (serving size) corresponding to a serving. Dietitians depict food portions using household food models, often known as 'handy measures' (food measurement instruments used to quantify portion sizes of food) [53, 56]. Weighing foods before eating them is inconvenient and inefficient. As a result, nutrient information on commonly consumed composite traditional Algerian foods with defined recipes, as well as an appropriate and reliable tool to assess and quantify their servings, has become critical, as it has been seen in countries such as South Africa, where photographs of food portion sizes are available [57].

Our results showed that the adequate serving size for couscous is 270 g from a nutritional point of view as depicted in the photograph (Fig. 1). This serving size provides the consumer with 10 g of protein which was used as a reference to define the serving because the contribution of protein in energy was found to be very small with it containing only 3.8 g/100 g. by determining the serving to 10g of protein we raised the caloric contribution of protein to 10% thus for the serving to be nutritionally adequate as per the recommendation of the UK department of Health which states that at least 10% of the total daily caloric intake should be from protein to prevent nitrogen loss. [58]

It is noticeable that most of the 942 kcal in a serving of couscous is provided mostly by the 162 g of carbohydrates and 28.134g of fat (Tab. IV). The amount of fiber per serving which is 52.110g gives bulk to the dish, making the consumer feel full for longer periods of times. It prevents overeating and contributes to a healthy microbiota.

CONCLUSION

To summarise, a serving of couscous provides good amounts of macronutrients, micronutrients, and a large quantity of fibre that contributes to creating substance making the dish a balanced meal of its own and contributes to a healthy microbiota. The quantity and quality of fat found in the study on couscous could be attributed to the vegetable oil and animal fat used in the cooking process. This research, however, is subject to several limitations as was based on only one recipe and it is known that there are multiple ways to prepare couscous. Although the findings of this study offer a better understanding of the composition of similar couscous dishes with a recipe close to the one used, further studies should be considered to cover the many versions of the dish, other parameters that contribute to the national aspects of foods such as glycaemic index and glycaemic load can also be investigated in the future.

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