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# Ethno-nutraceutical survey of dietary seaweeds used in unconventional therapy in Morocco. An emerging practice for a renovated pharmacopeia

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## Abstract

In Morocco, like in many developing countries, people usually tend to turn to unconventional therapies. An ethnophycological survey was realized to inventory seaweeds used in complementary Moroccan medicine. One hundred ninety-one (191) consumers and thirty-one (31) traditional healers were interviewed on seaweed food-related diseases using standardized questionnaires. The survey was conducted in some cities in Morocco. After gathering all the information, the data obtained were analyzed and summarized. The investigation has displayed emerging phycotherapy in Morocco. Consumers' knowledge about seaweeds is complex and various. Yet, most of them are convinced of their nutraceutical benefits for a healthy lifestyle. The healers strongly support the reliability of their recommendations in treating health problems according to what the literature shows. The present study has made a contribution in giving a clear picture of the status quo of dietary seaweeds therapies in Morocco, which is revealed as an emerging practice needed to renovate pharmacopeia. Therefore, it has allowed us to list some seaweeds that haven't been considered in any scientific investigation

before, which will be subject afterward to pharmacological tests to prove the claimed uses.

Keywords: Food science, Health sciences

## 1. Introduction

Malnutrition can be defined as a pathological status resulting from the undernourishment by deficiency or overfeeding by excess, relative or absolute, of one or more essential nutrients [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]. This may involve biological, psychological, familial, and sociocultural factors, each interacting throughout evolution and maintain infections leading to weakened immunity, increased sensibility to diseases, physical and mental developmental delay, and reduced productivity [11, 12, 13, 14]. Compared to other pathologies, these forms are often irreversible, potentially fatal, and deeply embedded in poverty and underdevelopment, therefore harming the sustainable development of affected populations [1, 11, 15, 16]. The disproportionate effects of these nutritional diseases and of their economic consequences make them a public health priority [11, 17]. Furthermore, nutritional recovery may influence both short and long term health outcomes by adequate food supplies [18]. Thus, International organizations such as the World Health Organization (WHO), United Nations Food and Agriculture Organization (FAO), United Nations of International Children's Emergency Fund (UNICEF), and governments have shown a growing interest in compounds derived from unconventional food with health-promoting effects [19, 20, 21, 22, 23]. Those justify the search for new therapeutic approaches, including the use of dietary seaweeds from the traditional pharmacopeia.

Morocco has several advantageous characteristics thanks to its strategic biogeographical and ecological conditions with an extensive coastline of over 3.500 km. However, the seaweeds field represents only a tiny economic activity mainly based on harvesting in the natural environment, generating a high dependence on environmental conditions [24, 25]. A national population survey carried out by the Moroccan Ministry of Health in 2011 highlighted that Morocco is undergoing an epidemiological, demographic, and alimentary transition [26, 27, 28]. Indeed, nutrition remains at the heart of socio-economic development in the country [29].

Despite the long history of traditional medicine in aromatic and medicinal plant practices [17, 30, 31, 32], and the wide evidence of literature emphasizing the nutritional benefits of seaweeds [33, 34, 35], the expertise on unconventional nutraceutical seaweeds remains relatively underestimated in this country. Indeed, the lack of sensibilization, low purchasing power, illiteracy, geographical distance, training, diversity of cultural levels, linguistic partitioning as part of the population care are some of the factors responsible for the underrecognition of the benefits of phycotherapy in malnutrition disorders prevention. In addition, this study highlights ethnic

differences in Morocco compared to the other race/ethnicity groups [36, 37], and by demonstrating that the education on healthy eating behaviors and health care providers are intimately tied to the current recommendations and overall diet quality [8, 9, 26].

It is under these circumstances that we are interested in the dietary seaweeds used in unconventional therapy. The purpose of this study is to investigate for the first time the current unconventional practice based on seaweeds to nutraceutical support across Morocco.

## 2. Materials & methods

### 2.1. Survey

The survey was developed to determine the unconventional therapy practices of seaweeds in Morocco. The survey assesses the socio-professional characteristics of the consumers and healers samples and lists the seaweeds that they use for health benefits. Thus, two survey sheets were designed to understand if consumers are aware of seaweeds and whether they make the link between seaweeds and healthy food on the one side, and understanding how traditional healers operate on the other side. The potential consumers' survey sheet had questions related to the characteristics of the knowledge, preferences, and consumption frequency; open questions on the general perception of consumers towards seaweeds and their knowledge about them; consumption habits (frequencies and consumption modes) (Annex 1). The survey among potential healers had questions related to the socioeconomic characteristics (profile, age, training, experience); and on their knowledge concerning the benefits of seaweeds (Annex 2). Given the anonymous collection of data, ethical approval was not necessary.

### 2.2. Procedure

A preliminary survey in the field was conducted in 2014 to provide a database to guide the study area and sampling strategy. Thus, seven cities were selected for the study: Marrakech, Agadir, El Jadida, Casablanca, Rabat, Tanger, and Oujda, where we interviewed Arabic and Berber consumers and healers (Fig. 1).

The survey was carried out face to face, allowing us to obtain a good understanding of the questions and also to conduct the survey well. In addition, unstructured interviews were accomplished with the help of a local translator when necessary.

Study participants were interviewed in 2015–2016 in public places (supermarkets, markets, universities, and streets) to ensure diversity in the sample population that provided a wide range of different profiles. As for healers consenting to the study, they were interviewed in 2015 and in 2016 mainly carried out in their workplaces and information was recorded in non-standard formats. Each practitioner was



**Fig. 1.** Location of survey cities.

interviewed individually to provide independent information. Moreover, the people questioned were chosen insofar as they should be available to our survey duration length so that they will be more inclined to discuss their views.

Both questionnaire sheets were completed by socio-professional data. Surveys were adapted to the interviewer and to the increasing complexity of the information as the survey progressed. The set target was to investigate at least 250 consumers and 50 healers. However, only 222 consumers and 31 healers were available for final analysis.

### 2.3. Statistical analysis

The statistical methodology was based on two axes: descriptive statistics and analytical statistics using SPSS software (version 21.0). In the first part, we calculated the frequencies and characteristics of each variable studied, which gave us a general idea of the respondents. The results were expressed as a percentage for the qualitative variables. In a second step, we used the  $\chi^2$  test to determine if a significant difference exists between certain qualitative variables.

## 3. Results and discussion

### 3.1. Moroccan consumers

Among the 520 interviewed potential consumers, there are only 191 that have agreed to provide information.

### 3.1.1. Consumers' sociocultural status

Consumers were distributed as follows (Figs. 2, 3, and 4).

Fig. 2 shows the distribution of respondents according to their gender. We noted that the female gender represents almost the totality of our survey with 84 % (n = 187), whereas males represent only 16 % (n = 35) with the gender ratio is in favor of females (gender ratio  $\text{female/male} = 5.34$ ). There is also a highly significant difference between the two genders ( $p < 0.05$ ).

Fig. 3 shows the distribution of respondents according to their age. We noted that the 63 % (n = 140) aged between 20 and 50 years are the majority compared to the other age groups aged less than 20 years with 29 % (n = 64) and those above 50 years 8 % (n = 18). There is also a significant difference between the three modalities studied ( $p < 0.05$ ).

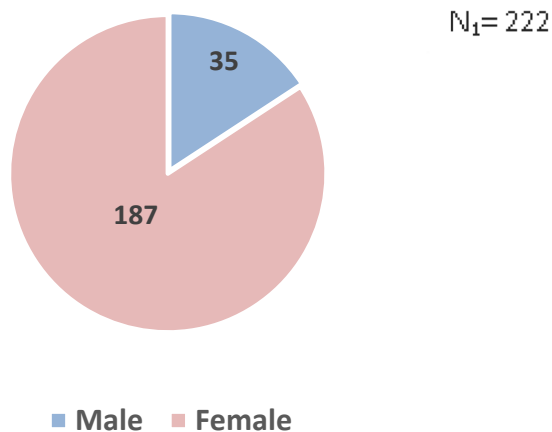


Fig. 2. Gender consumer profile.

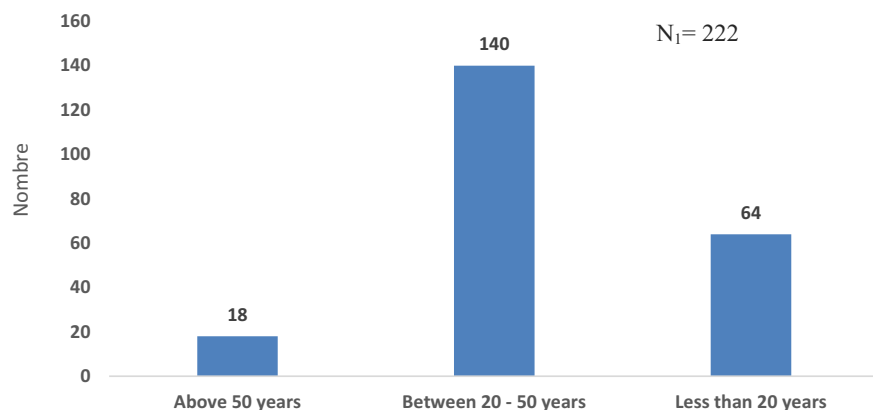
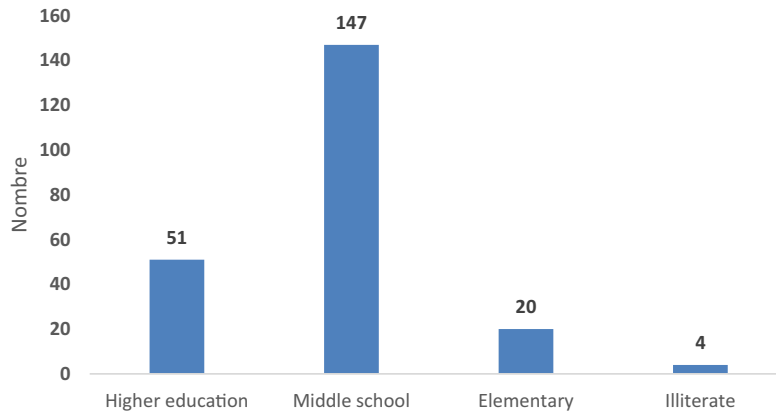


Fig. 3. Age consumer profile.



**Fig. 4.** Level of qualifications consumers 'profile.

Similarly, Fig. 4 shows the distribution of respondents according to their level of education. We find that 66 % (n = 147) of respondents with a middle school level, against 2 % (n = 4) are illiterates.

This showed that women were considerably more interested in seaweed products than men and those young consumers were the most interested in this food trend. Also, the level of education had an impact on adherence to this type of diet. Thus, based on these sociocultural results, the phycotherapy practiced by the Moroccan population depends on age, level of education, and gender.

### 3.1.2. Potential consumers

The potential consumers could be divided into four main groups (Table 1) as 4.7 % (n = 9) people resorted only to the phycotherapy; 76.9 % (n = 147) people resorted only to modern medicine; 15.18 % (n = 29) people resorted to both phycotherapy and to modern medicine and 14 % (n = 31) people were unaware of their consumption. There is a significant difference between modalities ( $p < 0.05$ ).

**Table 1.** Consumption of seaweeds in the population.

| Potential consumers   | n   | %     |
|---|-----|-------|
| people ignoring their consumption   | 6   | 3,14  |
| people resorting only to the phycotherapy   | 9   | 4,71  |
| people resorting only to modern medicine  | 147 | 76,96 |
| people resorting at the meanwhile, to the phycotherapy and to the modern medicine | 29  | 15,18 |
| unknown   | 31  | 14,00 |

Consumers were urban and rural (farmers, officers, students, and illiterate people). They view seaweeds as an exotic food item (in Japan, Korea, China, and Western countries), their increasing acceptance could be explained by current Asian catering to improve in diet standing [38, 39, 40, 41, 42]. Non-consumers (80.1 %) reported organoleptic characteristics such as the iodine taste, bitterness, and crunchy texture of seaweeds didn't suit their taste. However, both groups reported the innovative and biological characteristics of seaweeds but considered them poor in calories and rich in fiber, proteins and trace elements, especially magnesium and iodine [43, 44, 45]. Therefore, the use of nutraceutical seaweeds in Morocco is complicated and dictated by different overlapping beliefs and foreign skills.

### 3.1.3. Recognition of seaweeds species

Since we wanted to understand the reasons why people consumed seaweeds, we considered both consumers and non-consumers. We, therefore, asked them to name the edible seaweeds that they know (Fig. 5).

Among the consumers, 79 % could name  $\geq 3$  of edible seaweeds and 21 % name more than three ones. However, 96 % of non-consumers recognized less than three alimentary seaweeds and only 4 % managed to name more than 3 seaweeds. Hence, consumption is strongly related to openness to foreign skills [46, 47].

### 3.1.4. Consumption frequency

Seaweed consumption frequency was divided into several times a week, several times a month, several times a year, or never. A cumulative variable was created to determine the consumption frequency of each individual. Points were attributed according to the observed frequency for each consumption frequency: 52 points per week, 12 points per month and 1 point per year. The sum of points accumulated allowed the classification of individuals into four classes defined in Table 2.

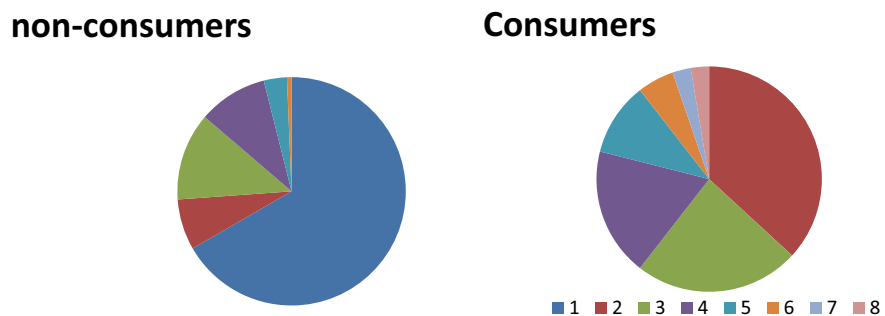


Fig. 5. Number of known species by consumers (top) and non-consumers (below).

**Table 2.** Consumers' classification according to seaweeds consumption frequency.

| Frequency of consumption |                     | Percentage of consumers |
|--------------------------|---------------------|-------------------------|
| Low                      | < one per month     | 41 %                    |
| Regular                  | 1–2 times per month | 33 %                    |
| Frequent                 | < once per week     | 17 %                    |
| ≥ Once per week          | ≥ Once per week     | 9 %                     |

From a quantitative point of view, significant differences were identified with regards to this food group without considering age and gender. Less than 42 % of consumers consumed seaweeds at least once per month. Overall, 59 % of consumers regularly consume seaweeds, 9 % consuming it very frequently.

Therefore, the average consumption of seaweeds was not negligible. This shows that the surveyed population commonly practices phycotherapy, not only for pleasure but also for health benefits. Seaweeds are a liable alternative to cover the recommended intake of protein, vitamins, and iron, especially for children, women, and for seniors prone to deficiencies in certain nutrients. Furthermore, the rural areas population reported practicing phycotherapy by going to traditional healers during the days of the souk (weekly market) or independently after having heard about it on the radio or the television, while people in urban areas go to traditional practitioners due to their notoriety and through discovering recipes on the internet. However, the investigation season and availability of seaweeds in the environment (seasonality) may have had an impact on the observed prevalence [40, 41].

### 3.1.5. Pathologies treated by phycotherapy

The uses of algae for treating diseases by consumers are mentioned below in Fig. 6.

Most respondents in both genders consume algae as a remedy mainly to lose weight, to stimulate the immune system and to provide the necessary micronutrients to the body 80 % (n = 28) for men, 70,05 % (n = 131) for women. This result is in agreement with previous reports, which confirms that seaweeds nutritional regimes are leading to well-being by decreasing widespread and chronic risk factors [48, 49, 50]. Furthermore, the interviewed consumers claimed that they were satisfied with the various nutritional and functional activities of seaweeds. Therefore, they were convinced that seaweeds should be part of their diet.

## 3.2. Traditional healers

Among 50 interviewed healers, there are only 31 that have agreed to provide information.



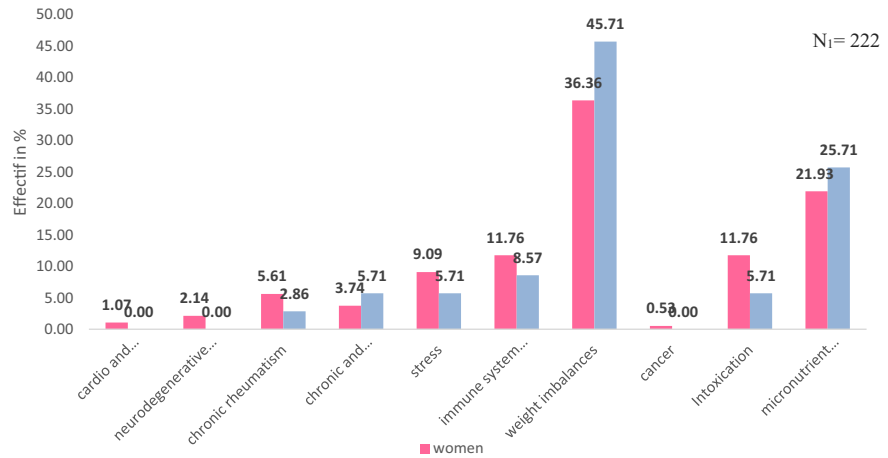


Fig. 6. Consumers' classification according to seaweeds.

### 3.2.1. Healers region

The interviewed healers were distributed over the seven selected cities of Morocco that have undergone significant development: 27 % (n = 8) in Marrakech followed by Casablanca 25 % (n = 7), Rabat 18 % (n = 6), Agadir 15 % (n = 4), El-Jadida 9 % (n = 3), Tanger 5 % (n = 2), and Oujda 1 % (n = 1) (Fig. 7)

Therefore, these results suggest that residents of coastal cities are more sensitive and open to this practice.

### 3.2.2. Healers' experience

The careers and the qualifications of healers are mentioned in Fig. 8.

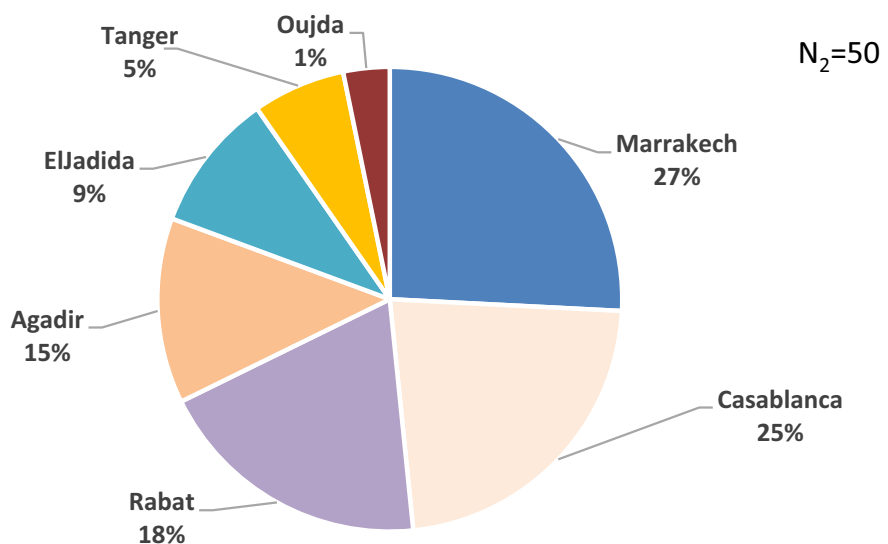
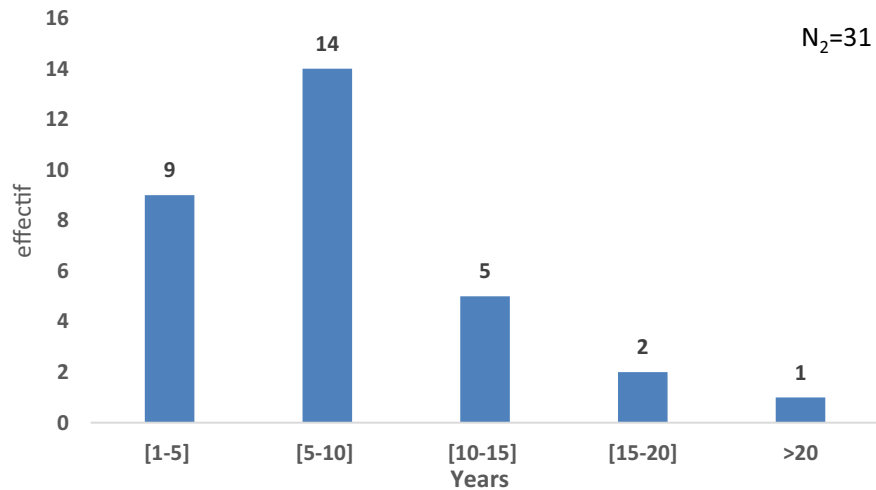


Fig. 7. Distribution of healers by cities.



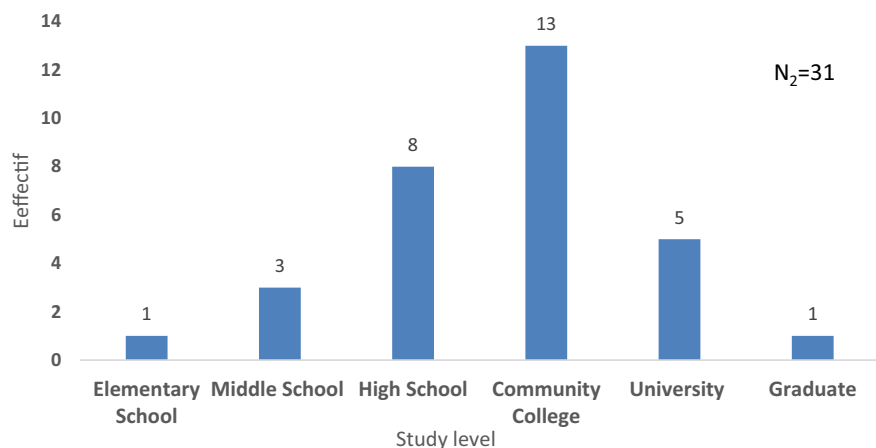
**Fig. 8.** Experience of traditional healers in years.

It is noted that 74 % (n = 23) have been practicing for at least a decade, while 25.8 % have been practicing for more than a decade. Their expertise to cure pathologies with algae is supported on their knowledge accumulated over the years and the training and the sharing of knowledge between each other. Furthermore, the healers were mostly young, and their competence would explain the easy interaction with consumers, which certainly influences their diagnostic quality, advice, and services.

### 3.2.3. Level of study

All surveyed healers were literate, 87.09 % (n = 27) reached a higher level of education, while 12.9 % (n = 4) had a lower or equal level to high school (Fig. 9).

Each possessed at least one traditional medical book and some scientific publications or reviews. Otherwise, 5% of them made a living mainly from their job. Furthermore,



**Fig. 9.** Study level of traditional practitioners.

they disapproved the absence of organizations in Morocco to fund such professional training. Consequently, they must fund their own apprenticeships: 19 % of healers are investing in diploma courses while 42 % are investing in certified training.

### 3.2.4. Medication

78 % of the healers interviewed claimed that their customers resorted to self-medication using both phyco and phyto-therapy to obtain an effective treatment for their symptoms. The remaining 22 % of the healers interviewed confirmed that the diagnosis was conducted by a doctor. Nonetheless, the patients seek traditional practitioners looking for a remedy. The healers' diagnostics determined the affected organ by the disease that is likely responsible for the illness based on appearance, diet, and history. Healers classified consumers into three categories such as the first preferred the dried form, the second preferring the fresh form, and the third category preferring the galenic form of diet supplement. Thus, adherence to treatment was defined by these preferences. To this end, the persistence of unconventional medicine in Morocco could be explained by either a lack of time or means to consult a medical specialist or by temporarily treating illness while waiting for a medical opinion and also by their real ability to remedy.

### 3.2.5. The most used seaweeds

The data processing of questionnaires permitted us to examine the consumption of seaweeds according to seaweeds classes (Fig. 10).

In terms of the choice of algae color consumed by the surveyed populations (healers and consumers), we found that the green algae are the preferred ones by the

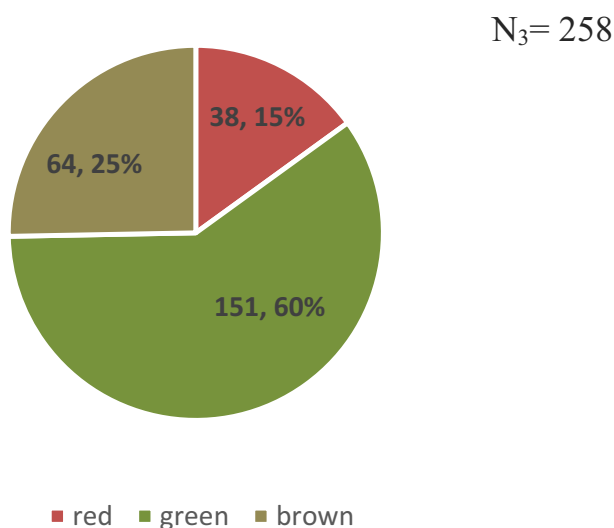


Fig. 10. Principal seaweeds classes the most used in nutraceutical therapy.

respondents with a percentage of 59.7 % (n = 151), followed by the algae the browns 25.2 % (n = 64) while the red algae represent only 15.1 % (n = 38) with a significant difference ( $p < 0.05$ ).

The red ones (*Chondrus crispus*; *Gracilaria Verrucosa* (*Ogonori*); *Plamara Tenera* (*Nori*); *Palmaria palmate* (*la Dulse*)) were the most valued consumed with 59.7 %, followed by brown (*Ascophyllum Nodosum*; *Fucus vesiculosus*; *Himanthalia elongate* (*Haricot de mer*); *Laminaria digitata* (*Kombu Breton*); *Undaria pinnatifida* (*Wakame*) with 25.19 %, and green seaweeds (*Spirulina*; *Ulva lactuca* (*Sea Lettuce*); *Chlorella vulgaris*) with 15.11 %. The greater part of these dietary was mainly got commercial products, imported from abroad, while few algae are locally collected (*Ulva*, *agar-agar*, and *Spirulina*). The dry form was the most quoted with 87.1% (n = 27) and encapsulated form only represents 12.9% (n = 4). Therefore, this result suggests that the color has an impact on the food choices of the population surveyed. Moreover, consumers are now aware that their diet impacts their health, which could explain the keen interest of the rest that is open to medical specialists that follow complementary approaches, especially the dermatologists, nutritionists, dieticians, and gynecologists. It has indeed been noticed that many of them are self-trained and invest in this area of specialization outside their conventional medical training.

#### 4. Conclusions

This survey allowed us to better understand the trend of unconventional uses of edible algae in some regions in Morocco. In the context of our study, following the questionnaire sheets, the healers and consumers expressed their perceptions, impressions, preferences, knowledge, and know-how about algae with nutraceutical advantages. Despite the scarce knowledge on the composition and nutritional values of seaweeds, Moroccan consumers identified a considerable amount of algae mostly used in treating various health issues related to habits and current lifestyle. In fact, the Moroccan community classified them before based on their dietetic habits, but nowadays, they have a relatively short traditional use in unconventional therapy. As more information about algae components is being accumulated, more people are becoming familiarized with them as part of a slow but steady diet. Traditional healers have recommended the chemical composition of diverse species of algae. These dietary algae help prevent diseases due to malnutrition. In addition, healers, who are usually high school graduates, are experienced as they have been practicing for a long time. Their knowledge and the uses of medicinal algae and their properties are generally acquired followed by long experience. 61 % of them voluntarily follow continuous training. It is a positive point that indicates that they keep learning and it is fair to say that with their accumulated experience as they age, their development in Morocco is predictable. 78 % of them also practice self-medication.

They all expressed the wish to develop collaboration between modern medicine and traditional medicine. The creation of bridges between these two approaches is to be organized, mainly through congresses and seminars.

Finally, we can confirm that Morocco is currently conscious of the health benefits linked to seaweed utilization. Thus, further studies should aim to contribute to the knowledge of edible algae for their nutritional benefits, whose properties are still not completely known. Their value in the Moroccan pharmacopeia will be reinforced as they establish a strong position in the pharmaceutical market.

## Declarations

### Author contribution statement

R. Seghiri: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

A. Essamri: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

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### Competing interest statement

The authors declare no conflict of interest.

### Additional information

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2019.e01559>.

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