Background

Halitosis, also commonly known as “bad breath” is a condition characterized by unpleasant odors emanating timely from the oral cavity [1-3], and which affect more than 30% of the general population [4]. The etiology of halitosis involves many intra- and extra-oral factors such as gingivitis, periodontitis, nasal inflammation, chronic sinusitis, diabetes mellitus, liver insufficiency, cirrhosis, uremia, lung carcinoma, trimethylaminuria, and postnasal drip [5]. However, the most common source of halitosis is the oral cavity itself (90%) [6]. Indeed, bad breath derived from the mouth is mainly caused by volatile sulfur compounds including hydrogen sulfide, methyl mercaptan, and dimethyl sulfide, produced through the putrefaction activity of oral bacteria [7-9].

Managing the halitosis is based on one hand on good oral hygiene cleaning, that reduces by 25% the CSV rates present in the oral air [10,11], and on the other hand on the treatment of oral diseases when necessary. In some case, patients can also turn to “soft” medicine that offers a wide range of disciplines to treat bad breath; homeopathy, herbal medicine and aromatherapy as alternative treatments, or complementary to conventional medicine.

This traditional mode of treatment had always been used largely by Moroccans as Arabs and Africans. By its geographical and climate diversity, Morocco has a wide range of species of aromatic plants. There are about 800 species of medicinal and aromatic plants that are potentially exploitable. Taking into account this natural wealth, and especially for cultural...
and economic reasons, the use of medicinal plants is still widespread in the Moroccan society. According to the WHO 2003 statistics (World Health Organization [WHO]), in some developing countries in Asia, Africa, and Latin America, 80% of the population use traditional medicine to meet their needs for primary health care. WHO has established a list of herbal monograph classifying them into three categories: Plants whose use is supported by clinical data, those whose use is supported by pharmacopeia and traditional systems of medicine and those whose use is reported in the popular milieus, but not based by clinical and experimental studies [12].

The main objective of this study was to know the medicinal plants used by herbalists for treatment of halitosis.

METHODS

This is a cross-sectional study, conducted from November 2015 to May 2016, including all forms of traditional healers (TH) from five Moroccan cities: Rabat, Salé, Témara, Khémisset, and Tiflet.

The instrument used for this study was a questionnaire in which questions were either binary choice (yes/no) or multiple choices. The questionnaires were self-administered to TH to elicit information from them. Those TH who were unable to read or write were interviewed and their responses captured. Information elicted was demography of the TH, the local names of the medicinal plants/products used for the management of orofacial problems.

The questionnaire covers three parts: The first part treated the sociodemographic characteristics; the second part interested to the phytotherapeutic practices of patients; the third part concerned the names of prescribed medicinal plants used for the management of halitosis their routes of administration and methods of usage. The TH were also surveyed about their knowledge and practice regarding toxicities and contraindications of prescribed plants.

Herbalists were selected by convenience sampling. We asked all herbalists located in the five cities in their grocery stores, the first point of contact city officials was the herbalist’s representatives who communicate the contact details of all traditional practitioners.

The inclusion criteria were herbalists who prescribe herbs for dental and oral problems. The exclusion criteria were herbalists who are limited only to the sale of medicinal plants and herbalists who do not prescribe medicinal plants for oral pathologies.

Statistical Analysis

Data obtained were analyzed using the Statistical Package for Social Sciences (SPSS version 13.0, SPSS Inc., Chicago, IL, USA) and summarized using descriptive statistics and presented as frequencies and percentages.

### RESULTS

A total of 171 questionnaires conducted among herbalists, were recovered and exploited. The mean age was 44.23 ± 7.4 years.

The majority 72 (42.1%) resided in Rabat. 139 (95%) were males. More than a half 86 (50.3%) had a primary school education, 61 (35.7%) informal, 18 (10.5%) secondary education, and 6 (3.5%) only university education. No statistical difference between age and educational level was found. The overage of years of experience in traditional therapeutics for TH was 15.84 ± 7.5 years. 138 (81.2%) reported that they had never received any training in their field [Table 1].

This study showed that 23 plants were used to treat bad breath [Table 2]. These plants were used alone or as a combination of two or more varieties in the same recipe [Table 3]. All TH have confirmed that patients use medicinal plants for the treatment of bad breath, and they have also quotes the most used plants by Moroccan patients [Table 4].

### DISCUSSION

In this study, more than two-thirds of TH was older than 40 years. The most senior of them were illiterate, and <32% had formal training. It can be noticed that there was no significant difference between age and education level (P = 0.88). Furthermore, the training was not standardized, as most were trained by fathers, uncles, and other senior TH. The average duration of experience was 16 years depending on the ability of the apprentice. It can be suggested that because of their longer training, herbalists have good knowledge and skills to treat the patient by medicinal plants. There is a long and venerable history of the use of medicinal plants to treat wide varieties of oral diseases. Indeed, plants contain phytochemicals such as alkaloids, tannin, essential oils, and flavonoids that could have a high antimicrobial and anti-inflammatory efficacy.
Table 2: Medicinal plants used for the treatment of halitosis by traditional healers

| Family scientific name | Local name | Common name | Part used | Form of preparation | Method of administration | Frequency of citation by traditional healers (n, %) | Recorded literature for odontological uses |
|------------------------|------------|-------------|-----------|---------------------|--------------------------|-------------------------------------------------|-------------------------------------------|
| Apiaceae | *Foeniculum vulgare* | El besbas | Fennel | Leaves/seeds/ root | Infusion | Mouthwash | 20 (11.7) | Not found |
| | *Pimpinell anisium* | Nafae | Anise | Seeds | Infusion | Mouthwash | 12 (7) | Antibacterial effect of hydroalcoholic extract [13] |
| Apocynaceae | *Nerium oleander* | Ddeflia | Oleander | Stem | Infusion | Massage/friction | 10 (5.8) | Gingivitis [14,15] |
| Asteraceae | *Tanacetum cinerariifolium* | Taghen test | pyrethrum | Whole/leaves | Infusion/decoction/ Grinding | Mouthwash | 16 (9.4) | Not found |
| Juglandaceae | *Juglans regia* | Guaraguato | Walnut | Bark/leaves | Infusion | Mouthwash/Brushing | 38 (22.2) | Antibacterial against oral pathologic bacteria [16] |
| Lamiaceae | *Ajugaiva* | Chendgora | Mariout | Stem/leaves | Infusion | Mouthwash | 9 (5.3) | Not found |
| | *Marrubium vulgare* | Naanaa | Abdi | Whole | Infusion | Mouthwash | 4 (2.3) | Toothache [14,15,17] |
| | *Mentha piperita* | Fliyou | Pennyroyal | Whole | Infusion | Mouthwash | 39 (22.8) | Halitosis [14,18,15] |
| | *Origanum vulgare* | Yazir | Rosemary | Whole | Infusion | Mouthwash | 16 (9.4) | Anti-inflammatory and antimicrobial potential therapy for oral opportunistic microorganisms [19] |
| | *Rosmarinus officinalis* | Salmiya | Sage | Whole | Infusion/decoction/paste | Mouthwash/Friction/direct application | 40 (23.4) | Oral mucositis, dental pains, gingivitis [18,20,21] |
| | *Salvia officinalis* | Galima | Thyme | Whole | Infusion | Mouthwash | 31 (18.1) | Gingivitis [14,24] |
| | *Thymus vulgaris* | Ziitra | Thyme | Whole | Infusion | Mouthwash | 40 (23.4) | Periodontitis [25] |
| Lauracées | *Cinnamomum zylanicum* | Karfa | Cinnamon | Bark | Infusion/decoction | Mouthwash | 23 (13.5) | Induction of oral erythema multiforme like sensitivity reaction [23] |
| | *Laurus nobilis* | Wrap sidna moussa | Noble laurel | Leaves | Infusion | Mouth rinse | 7 (4.1) | Not found |
| | *Lycraeae* | *Punica granatum* | Roummane | Pomegranate | Flower | Gringing/Paste | 4 (2.3) | Gingivitis [14,24] |
| Magnoliaceae | *Illicium verum* | Badiane | Badian | Fruits | Infusion/decoction | Mouthwash | 52 (30.4) | Not found |
| Myristicaceae | *Myristica fragrans* | Lgouza | Nutmeg | Fruits | Mouthwash | 20 (11.7) | Gingivitis [21], stomatitis [26] |
| Myrtaceae | *Syzygium aromaticum* | Krounfei | Clove will | Flower | Infusion | Mouthwash/Direct application | 30 (17.5) | Dental pain [27] |
| Oleaceae | *Ole europaea* | Zaytoune | Olive tree | Whole | Infusion | Mouth rinse | 39 (22.8) | Aphthous, stomatites, toothaches [26,28] |
| Salvadoraceae | *Salvadora persica* | Miswak | Miswak | Bark | Infusion | Brushing | 102 (59.6) | Oral hygiene [29] |
| Verbenaceae | *Aloysia citrodora* | Lwiza | Odorous vervain | Whole | Infusion/gringing | Mouthwash/direct application | 12 (7) | Toothache, tooth cleaning [30-32] |

(Contd...)
Table 2: (Continued)

| Family scientific name | Local name | Common name | Part used | Form of preparation | Method of administration | Frequency of citation by traditional healers (n, %) | Recorded literature for odontological uses |
|------------------------|------------|-------------|-----------|--------------------|--------------------------|-----------------------------------------------|------------------------------------------|
| Elettaria cardamomum   | Kaakella   | Cardamom    | Seeds     | Infusion/grinding/hydroalcoholic extracts | Mouthwash/direct application | 130 (76)                                      |                                          |

Table 3: The most important associations of medicinal plants used in the treatment of halitosis by traditional healers

| Associations no | Plants | Frequency of citation by traditional healers (n, %) |
|-----------------|--------|---------------------------------------------------|
| 1               | Cinnamomum zylanicum, Mentha piperita, Mentha pulegium, Origano vulgare, Salvia officinalis | 139 (81.3) |
| 2               | Juglands regia, Marrubium vulgare, Origano vulgare, Syzygium aromaticum | 122 (71.3) |
| 3               | Elettaria cardamomum, Pimpinella anisium | 113 (66.1) |
| 4               | Cinnamomum zylanicum, Illicium verum, Syzygium aromaticum, Tanacetum cinerariifolium | 113 (66.1) |
| 5               | Aloysia citrodora, Cinnamomum zylanicum, Foeniculum vulgare, Laurus nobilis, Mentha piperita, Myristica fragrans, Pimpinella anisium, Syzygium aromaticum, Thymus vulgaris | 69 (40.4) |
| 6               | Juglands regia, Oleo europaea, Syzygium aromaticum | 49 (28.7) |

Table 4: The most researched plants by Moroccan patients according to traditional healers

| Plants                     | Frequency of citation by traditional healers (n, %) |
|----------------------------|---------------------------------------------------|
| Elettaria cardamomum       | 111 (64.9)                                        |
| Illicium verum             | 58 (33.9)                                         |
| Cinnamomum zylanicum       | 44 (25.7)                                         |

The results of this survey revealed the use of 23 major plants belonging to 14 families in managing halitosis [Table 2].

Ethnobotany analysis of plant prescribed by herbalists and used by the patients in this study showed that they mainly belong to the family of Lamiaceae including eight species [Table 2]. This plant family is known for its wide global distribution, with over 7200 species across 240 genera [33]. In the studied region, “Kénitra-Rabat-Temara” it had been shown a predominance of species of the family Lamiaceae [34] which can explain its large use, as a local product, by the TH. However, when considered as a plant the most prescribed ones were; Elettaria cardamomum, Salvadora persica, Illicium verum, and Origano vulgare.

E. cardamomum was widely used by TH (76%), and it was also the most researched plant by patients (64.9%) to treat halitosis. Although we did not found a literature data on its use in managing halitosis or oral diseases, we think that this plant could be useful as it has been proven to be active against many pathogenic Gram-positive and Gram-negative bacteria [35-37]. Its association with Pimpinella anisium was also prescribed by more than half of TH (66.1%). It was shown that hydroalcoholic extracts from P. anisium have an antibacterial effect on cariogenic bacteria [38].

S. persica (Miswak) was widely used (59.6%) to treat halitosis. This plant is known for its anti-inflammatory effect [39], it also contains vitamin C that helps in healing gingival edema and bleeding [14]. In a study comparing the Miswak (S. persica) with the effect of the conventional toothbrush on the periodontal health of users, Darout et al. 2003 [40] showed better results for this plant in the reduction of dental plaque and the resolution of gingivitis. Many studies showed the significant effect of Miswak as an antibacterial agent. The inhibitory role of this plant on both Gram-positive and Gram-negative bacteria and fungi residing in the oral cavity has been demonstrated both clinically and experimentally. It contains salvadoreine and trimethylamine, that exhibit antibacterial effects on cariogenic bacteria such as Streptococcus mutans and that reduces the accumulation of biofilm supporting, therefore, periodontal health [14].

I. verum (Badian) was prescribed by 52% by TH and used by 58% of patients to treat halitosis. It had been shown that this plant possesses a potent antimicrobial property due to the presence of anethole. Studies with isolated anethole from I. verum indicated that it is effective against bacteria, yeast, and fungal strains (Feng et al., 2010) [42]. It had been reported also, that this plant seems to have a good activity against Eikenella corrodens, but less active against Porphyromonas gingivalis, Porphyromonas asaccharolityca, Prevotella melaninogenicca, Prevotella intermedia, Fusobacterium nucleatum, Capnocytophaga gingivalis, Veillonella parvula, E. corrodens, Peptostreptococcus micros, and Actinomyces odontolitycus (Iauk et al., 2003) [43].

O. vulgare was prescribed by 35.1% of TH. This plant is widely studied for its antibacterial effect in many systemic diseases, and more recently Khan et al. (2017) [44] reported its effect on cariogenic bacteria because of the presence of carvacrol and thymol.

TH also prescribed Thymus vulgaris (Thyme) 31% and Syzygium aromaticum (Clove) 17.5%. These prescriptions are consistent
with the literature data. Indeed, in a survey of students from the Faculty of Pharmacy, Lamendin et al. 2009 [45] showed that S. aromaticum (Clove) and T. vulgaris (Thyme) were most used for diseases of the oral mucosa. S. aromaticum (Clove) being an anti-infective, antiseptic, analgesic, [39] and anti-inflammatory [46], has its indication in all oral disease including gingivitis [9,14,15,47]. Furthermore, T. vulgaris (Thyme), through its various antiseptic and antioxidant properties [48,49], is widely reported in gingivitis, stomatitis, and bad breath [6].

As halitosis is in most cases caused by bacteria colonizing mouth, thus using the above plants as antiseptics in treatment of oral diseases can help on resolving oral malodor. Indeed, the majority of the most used plants in this study exhibit some chemical compounds that can explain their effects [Table 5].

We asked TH also if they have knowledge about toxicity and counter-indications, less than 6% were aware of the related toxicity to the improper use of plants and a less than 10% were aware of against indications. Nevertheless, they insist especially regarding the side effect and adverse effect of this product [71].

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**CONCLUSION**

Considering the growing interest of natural plant molecules as efficacious and safe substances for oral health care when properly used, the preliminary results of this work allow knowing the plants used in this population. This data could be the base for experimental and clinical studies promoting the use of natural agents in the treatment of bad breath.

| Plants                  | Compounds          | References                          |
|-------------------------|--------------------|-------------------------------------|
| Cinnamomum zylanicum    | (E)-cinnamaldehyde | Unlu et al. (2010) [51]             |
| Illicium verum          | (E)-anethole, anisyl acetone, anisyl alcohol and anisyl aldehyde | Yang et al. (2010) [42]            |
| Mentha piperita         | Menthol and menthone | Iscan et al. (2002) [51]            |
|                         | Linalool           | Kozlowska et al. (2002) [52]       |
|                         |                    | Kozlowska et al. (2015)[52]        |
|                         |                    | Ras et al. (2010) [53]             |
|                         |                    | Khadir et al. (2016) [54]          |
| Mentha pulegium         | Piperitone         | Mahboubi and Haghi (2008) [55]     |
|                         |                    | Kozlowska et al. [52]              |
|                         |                    | Vieira et al. (2017) [56]          |
|                         |                    | Aires et al. (2016) [57]           |
| Origanum vulgare        | Polyphenols        | De Martino et al. (2009) [58]       |
|                         | Carvacrol and thymol | De Martino et al. (2009) [58]    |
|                         |                    | Kozlowska et al. [50]              |
|                         |                    | Khoury et al. (2016) [59]          |
| Salvia officinalis      | Thujone, 1,8-cineole and camphor | Delamare et al. (2007) [60]      |
|                         |                    | Jansenjak et al. (1987) [61]       |
|                         |                    | Sivropoulou et al. (1997) [62]     |
|                         |                    | Sur et al. (1991) [63]             |
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