Full Length Article

CHEMICAL COMPOSITION OF COMMON MEDICINAL HERBS USED FOR INDIAN TRADITIONAL MEDICINE

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ABSTRACT

A total of sixteen commonly available medicinal herbs (different parts) used in Indian traditional medicine were collected. The collected parts were, shade-dried, ground to fine powder and stored in air-tight containers. The samples were analyzed for proximate principles, acid-insoluble ash, gross energy, minerals and fatty acids. Emblica officinalis fruits had significantly (P < 0.05) highest moisture (88.67%), Moringa oleifera leaves had significantly (P < 0.05) highest crude protein (26.99 %), Coriandrum sativum seeds had significantly (P < 0.05) highest crude fibre (32.53%), Syzygium aromaticum buds had significantly (P < 0.05) highest crude fat (18.57 %), Mentha spicata leaves had significantly (P < 0.05) highest total ash (11.53 %), Allium sativum bulbs had significantly (P < 0.05) highest nitrogen-free extracts (90.14 %) and Murraya koenigii leaves had significantly (P < 0.05) highest acid insoluble ash (4.71 %). The gross energy content was significantly (P < 0.05) highest in Coriandrum sativum seeds (4605.33 Kcal/Kg). Azadirachta indica leaves had significantly (P < 0.05) highest calcium (2.99 %), Phyllanthus niruri leaves had significantly highest (P < 0.05) phosphorus (0.53 %), Andrographis paniculata stem and leaves had significantly (P < 0.05) highest copper (41.27 ppm), E. officinalis fruits had significantly (P < 0.05) highest iron (596.78 ppm) and S. aromaticum buds had significantly (P < 0.05) highest manganese (286.96 ppm). C. sativum seeds had significantly (P < 0.05) highest levels of oleic acid (73.76 %), T. foenum seeds had significantly (P < 0.05) highest levels of linoleic acid (36.43 %) and P. niruri leaves had the significantly (P < 0.05) highest levels of linolenic acid (51.78 %) Further studies are needed to quantify other bioactive compounds, to study their antioxidant and antimicrobial properties so that they could be used as alternatives to antibiotics / other drugs for livestock and poultry.

Keywords: Proximate composition, Gross energy, Acid insoluble ash, Mineral composition, Fatty acid profile, Indian herbs,

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INTRODUCTION

A number of herbs have been used as medicine for centuries throughout the world. Globally India ranks second in the export of medicinal plants both in terms of quantity and quality (Prasathkumar *et al*., 2021). Traditional medicines, mostly of plant origin, were and are the major source of health care for more than 80 per cent of the world's population. Worldwide herbal medicine is increasing in popularity because it is compatible, adaptable, and has minimal side effects. Chinese, Ayurveda and Unani medicine have been developed by preserving and expanding on the past experiences (Chanda *et al*., 2013). Ayurvedic medicine, that has its origin in India, makes use of natural resources that include salts, oils, water, herbs and their preparations to treat various disease conditions. The need to ban and or reduce the use of antibiotics at subtherapeutic levels, primarily as growth promoters, has triggered the usage of traditional herbal medicine in livestock and poultry. Herbal preparations from plants are readily available, inexpensive, safe, efficient, and rarely have side effects. Plants by nature produce a variety of secondary metabolites *viz.,* alkaloids, glycosides, terpenoids, saponins, steroids, flavonoids, tannins, quinones and coumarins (Tiwari *et al.,* 2011). These secondary plant metabolites actually contribute in alleviating several aliments in traditional medicine and in folk medicine practiced across the globe. In the era of modern medicine, secondary plant metabolites have provided lead compounds for the production of various pharmaceutical preparations that are used in the treating of minor to complicated life-threatening diseases. The preliminary knowledge on the chemical composition of herbs particularly their mineral and fatty acid profile will enable their better use for medicinal purpose. The present study hence evaluated the proximate composition, acid-insoluble ash content, gross energy, mineral and fatty acid profile of common medicinal herbs of Tamil Nadu.

MATERIALS AND METHODS

Sample Collection

Sixteen commonly available medicinal herbs *viz.*, *Allium sativum, Andrographis paniculata, Azadirachta indica, Cinnamomum verum, Coriandrum sativum, Curcuma longa, Emblica officinalis, Mentha spicata, Moringa oleifera, Murraya koenigii, Ocimum sanctum, Phyllanthus niruri, Piper nigrum, Syzygium aromaticum, Trigonella foenum - graecum and Zingiber officinale* were included in the study. The part that is traditionally used for medicinal purpose for each particular herb were identified and six samples of each were collected. The herbs and their parts selected for the study are listed in Table 1.

The samples were cleaned from extraneous matter, shade-dried for 72 hours and ground to pass through a 1 mm sieve using a Willey mill (Haniyeh *et al*., 2010) and were stored in air-tight containers for further analysis.

Proximate composition, acid-insoluble ash and Gross energy

The proximate composition (crude protein, crude fibre, ether extract, total ash and nitrogen-free extract) and acid-insoluble ash content of the samples were determined as per AOAC, (2012). The gross energy content (kcal/kg) of the samples was determined by calculation from proximate principles as per the equation of Halvar *et al.* (1976).

GE (Kcal/kg) = [100 – (M % + CP % + CF % + EE % + TA %)] x 4

{(CP % x 5.65) + (CF % x 4.00) + (EE % x 9.45)} x 10

Mineral profile

Mineral analyses (calcium, phosphorus, copper, iron and manganese) of the samples were carried out as per AOAC (2012).

Fatty acid profile

The fatty acid profile of volatile oil extracted from samples were determined as per the procedure of Bayne and Carlin (2010) using a gas chromatograph, GC model, Chemito (8610).

Statistical analysis

The data collected on the above parameters were subjected to statistical analysis (ANOVA) using IBM SPSS statistics version 20 software programme (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

The results of the proximate composition (crude protein, crude fibre, ether extract, total ash and nitrogen-free extract), acid insoluble ash and gross energy of the samples are presented in Table 2. Among the herbs analyzed *Emblica officinalis* fruits had significantly ($P < 0.05$) highest moisture (88.67%), *Moringa oleifera* leaves had significantly ($P < 0.05$) highest crude protein (26.99 %), *Coriandrum sativum* seeds had significantly ($P < 0.05$) highest crude fibre (32.53%), *Syzygium aromaticum* buds had significantly ($P < 0.05$) highest crude fat (18.57 %), *Mentha spicata* leaves had significantly ($P < 0.05$) highest total ash (11.53 %), *Allium sativum* bulbs had significantly ($P < 0.05$) highest nitrogen-free extracts (90.14 %) and *Murraya koenigii* leaves had significantly ($P < 0.05$) highest acid insoluble ash (4.71 %). *C. sativum* seeds had significantly highest ($P < 0.05$) gross energy content (4605.33 kcal / kg) and *E. officinalis* fruits had significantly lowest ($P < 0.05$) gross energy content (875.17 kcal / kg).

The results of the mineral content (calcium, phosphorus, copper, iron and manganese) of the samples are presented in Table 3. *Azadirachta indica* leaves (2.99 %), *Phyllanthus niruri* leaves (0.53 %), *Andrographis paniculata* stem and leaves (41.27 ppm), *E. officinalis* fruits (596.78 ppm) and *S. aromaticum* buds (286.96 ppm) had significantly ($P < 0.05$) highest calcium, phosphorus, copper, iron and manganese, respectively.

The saturated and unsaturated fatty acid content (per cent of fat) of different herbs are presented in Tables 4 and 5, respectively. *P. niruri* leaves (13.82 %), *A.*

sativum bulbs (35.24 %), *P. nigrum* seeds (6.60 %), *S. aromaticum* buds (82.52 %), *O. sanctum* leaves (1.20 %) and *P. nigrum* seeds (12.74 %) had significantly ($P < 0.05$) highest levels respectively for myristic, palmitic, palmitoleic, stearic, arachidic and behenic acids. *C. sativum* seeds (73.76 %), *T. foenum* seeds (36.43 %) and *P. niruri* leaves (51.78 %) had the highest ($P < 0.05$) levels of oleic, linoleic and linolenic acid.

Proximate composition, acid insoluble ash and Gross energy

Proximate analysis is an important index to classify the nutritional value of any feed ingredient or supplement. This study revealed a wide variation in the proximate composition between the herbal samples analyzed. Each herbal sample belonged to a different species, the plant parts used for the herbal sample also varied; they were bulbs / leaves / stems / barks / buds / fruits / rhizomes / seeds, these factors contributed to the variation in the proximate composition.

Variability or similarity existed in the proximate compositions of the herbal samples analysed in this study compared to that reported by other authors. The average moisture content of *E. officinalis* fruits was reported as 80.74 per cent by Priya and Khatkar (2013) which was lower (88.67 %) than that documented in this study. Oduro *et al*. (2008) reported similar crude protein content (27.51 %) in *M. oleifera* leaves. *C. sativum* seeds were reported to have a much higher crude fibre (37.14 %) than that reported in this study. The ether extract (18.57 %) of *S. aromaticum* buds in the present study was higher than that reported (12.1%) by Abdel-Tawwab *et al.* (2007). Mainasara *et al.* (2018) reported as high as 25 per cent total ash in *M. spicata* leaves. Bhowmik *et al.* (2008) reported much lower NFE (75 %) in *A. sativum* bulbs as compared to 90.14 % in this study. In *M. koenigii* leaves Saini and Reddy (2013) reported (1.25 %) acid-insoluble ash per cent which was comparatively lower than the 4.71 per cent reported in this study. The variations could be due to difference in varieties, weather and soil influence, stress factors, stage of harvest, etc.

The gross energy content of herbal samples analysed also showed wide variations. An earlier study also confirmed that calorific value significantly differs among different plant organs across various vegetation types and that it is higher for above-ground organs than for underground organs (Yan *et al.,* 2018).

Mineral profile

The study concurred with the findings of Lokhande *et al.* (2009) who had stated that most medicinal plants are rich in one or more of the minerals. However, variations were observed in the mineral content, between herbal samples assayed. These variations in mineral concentration, is mainly attributed to the differences in botanical structure, as well as in the mineral composition of the soil in which the plants are cultivated (Lokhande *et al.,* 2009). Other factors responsible for a variation in elemental content are preferential absorbability of the plant, use of fertilizers, irrigation water and climatological conditions (Rajurkar and Pardeshi, 1997).

Table 1. List of herbs and their part selected for the study

S. No.	Botanical name of the herb	Common name of the herb	Plant part used
1	*Allium sativum*	Garlic	Bulb
2	*Andrographis paniculata*	Nilavembu	Leaf with stem
3	*Azadirachta indica*	Neem	Leaf
4	*Cinnamomum verum*	Cinnamon	Bark
5	*Coriandrum sativum*	Coriander	Seed
6	*Curcuma longa*	Turmeric	Rhizome
7	*Emblica officinalis*	Amla	Fruit
8	*Mentha spicata*	Mentha	Leaf
9	*Moringa oleifera*	Moringa leaves	Leaf
10	*Murraya koenigii*	Curry leaves	Leaf
11	*Ocimum sanctum*	Tulsi	Leaf
12	*Phyllanthus niruri*	Keelanelli	Full plant with root
13	*Piper nigrum*	Black pepper	Flower bud
14	*Syzygium aromaticum*	Clove	Flower bud
15	*Trigonellafoenum graecum*	Fenugreek	Seed
16	*Zingiber officinale*	Dry ginger	Rhizome

Table 2. Proximate composition and acid insoluble ash (% DMB) content (Mean* ± S.E) of different herbs

S. No.	Name of the herb	Proximate composition						Acid insoluble ash	Gross energy Kcal/ Kg
		Moisture	Crude protein	Crude fibre	Crude fat	Total ash	NFE		
1	*Allium sativum* (bulbs)	$68.52^{e} \pm 1.00$	$7.61^{gh} \pm 0.29$	$1.07^{i} \pm 0.02$	$0.33^{j} \pm 0.01$	$0.86^{g} \pm 0.03$	$90.14^{a} \pm 0.27$	$0.02^{b} \pm 0.01$	$1368.33^{l} \pm 37.52$
2	*Andrographis paniculate* (stem and leaves)	$54.32^{i} \pm 0.29$	$7.55^{gh} \pm 0.47$	$31.15^{a} \pm 2.01$	$1.61^{hi} \pm 0.05$	$7.56^{cd} \pm 0.69$	$52.13^{g} \pm 2.01$	$0.38^{b} \pm 0.01$	$1869.67^{j} \pm 29.66$
3	*Azadirachta indica (*leaves)	$61.67^{h} \pm 0.22$	$16.37^{d} \pm 0.33$	$12.84^{d} \pm 0.14$	$2.35^{gh} \pm 0.13$	$8.20^{bc} \pm 0.26$	$60.24^{e} \pm 0.29$	$0.74^{b} \pm 0.04$	$1660.33^{k} \pm 17.73$
4	*Cinnamomum verum* (barks)	$10.68^{l} \pm 0.30$	$3.35^{i} \pm 0.18$	$24.10^{b} \pm 0.60$	$2.34^{gh} \pm 0.02$	$2.52^{f} \pm 1.14$	$67.69^{c} \pm 0.72$	$0.06^{b} \pm 0.01$	$3704.50^{ef} \pm 43.47$
5	*Coriandrum sativum* (seeds)	$8.00^{m} \pm 0.43$	$14.19^{e} \pm 0.27$	$32.53^{a} \pm 0.33$	$15.83^{b} \pm 0.99$	$4.29^{e} \pm 0.27$	$33.16^{i} \pm 1.54$	$0.10^{b} \pm 0.01$	$4605.33^{a} \pm 37.42$
6	*Curcuma longa* (*rhizomes*)	$12.03^{k} \pm 0.35$	$6.77^{gh} \pm 1.45$	$4.38^{h} \pm 0.08$	$3.05^{fg} \pm 0.28$	$6.89^{d} \pm 0.59$	$77.17^{b} \pm 0.55$	$0.72^{b} \pm 0.05$	$3550.83^{g} \pm 23.34$
7	*Emblica officinalis* (fruits)	$88.67^{a} \pm 0.38$	$3.50^{i} \pm 0.16$	$15.43^{c} \pm 0.22$	$0.64^{ij} \pm 0.10$	$3.40^{ef} \pm 1.11$	$77.03^{b} \pm 0.30$	$0.78^{b} \pm 0.05$	$875.17^{m} \pm 12.33$
8	*Mentha spicata* (leaves)	$85.26^{b} \pm 0.39$	$23.36^{b} \pm 0.19$	$14.17^{cd} \pm 0.33$	$2.70^{fgh} \pm 0.09$	$11.53^{a} \pm 0.39$	$48.25^{h} \pm 0.35$	$0.66^{b} \pm 0.12$	$2141.67^{i} \pm 22.54$
9	*Moringa oleifera* (leaves)	$73.23^{c} \pm 0.41$	$26.99^{a} \pm 1.13$	$9.48^{ef} \pm 0.66$	$3.61^{ef} \pm 0.19$	$7.73^{bcd} \pm 0.55$	$52.19^{fg} \pm 0.57$	$0.69^{b} \pm 0.19$	$3972.17^{c} \pm 34.50$
10	*Murraya koenigii* (leaves)	$64.17^{g} \pm 0.28$	$14.92^{de} \pm 0.69$	$15.60^{c} \pm 0.90$	$4.45^{e} \pm 0.57$	$8.64^{b} \pm 0.37$	$56.39^{f} \pm 1.36$	$4.71^{a} \pm 0.12$	$3783.33^{de} \pm 47.51$
11	*Ocimum sanctum* (leaves)	$70.89^{d} \pm 0.28$	$18.33^{c} \pm 0.62$	$13.92^{cd} \pm 0.40$	$4.39^{e} \pm 0.24$	$10.67^{a} \pm 0.10$	$52.70^{g} \pm 0.57$	$0.33^{b} \pm 0.03$	$3820.67^{d} \pm 17.29$
12	*Phyllanthus niruri* (leaves)	$67.19^{f} \pm 0.66$	$15.51^{de} \pm 0.39$	$25.56^{b} \pm 0.29$	$5.76^{d} \pm 1.15$	$7.11^{d} \pm 0.27$	$46.06^{h} \pm 0.49$	$0.48^{b} \pm 0.12$	$2442.83^{h} \pm 25.46$
13	*Piper nigrum* (seeds)	$10.45^{l} \pm 0.29$	$9.82^{f} \pm 0.35$	$13.91^{cd} \pm 0.23$	$6.92^{c} \pm 0.68$	$4.35^{e} \pm 0.13$	$65.00^{d} \pm 1.12$	$0.08^{b} \pm 0.01$	$3947.00^{c} \pm 37.80$
14	*Syzygium aromaticum* (buds)	$24.09^{j} \pm 0.18$	$6.32^{h} \pm 0.47$	$10.29^{e} \pm 0.14$	$18.57^{a} \pm 0.49$	$4.42^{e} \pm 1.22$	$60.39^{e} \pm 0.64$	$0.06^{b} \pm 0.01$	$3976.00^{c} \pm 12.00$
15	*Trigonella foenum (*seeds)	$9.19^{m} \pm 0.27$	$24.13^{b} \pm 0.51$	$7.67^{fg} \pm 0.12$	$5.94^{cd} \pm 0.12$	$2.86^{f} \pm 0.10$	$59.40^{e} \pm 0.64$	$0.04^{b} \pm 0.01$	$4239.83^{b} \pm 12.35$
16	*Zingiber officinale* (dry rhizomes)	$11.25^{kl} \pm 0.45$	$8.33^{fg} \pm 0.33$	$7.07^{g} \pm 0.87$	$2.85^{fg} \pm 0.37$	$4.35^{e} \pm 0.27$	$77.41^{b} \pm 0.50$	$0.83^{b} \pm 0.04$	$3668.50^{f} \pm 28.51$

*Mean of six observations

Means bearing different superscripts within column differ significantly ($P < 0.05$)

Table 3. Mineral content (Mean* ± S.E) of different herbs

S. No.	Name of the herb	Name of the mineral				
		Calcium (%)	**Phosphorous (%)**	**Copper (ppm)**	**Iron (ppm)**	**Manganese (ppm)**
1	*Allium sativum* (bulbs)	$0.57^{fg} \pm 0.02$	$0.29^{cde} \pm 0.01$	$23.31^{fg} \pm 0.39$	$303.50^{i} \pm 5.63$	$118.18^{cd} \pm 5.55$
2	*Andrographis paniculata* (stem and leaves)	$1.91^{b} \pm 0.20$	$0.28^{cde} \pm 0.01$	$41.27^{a} \pm 0.15$	$554.83^{c} \pm 5.34$	$52.37^{g} \pm 4.98$
3	*Azadirachta indica* (leaves)	$2.99^{a} \pm 0.00$	$0.24^{ef} \pm 0.01$	$18.48^{i} \pm 0.38$	$423.56^{e} \pm 5.85$	$64.00^{g} \pm 4.98$
4	*Cinnamomum verum* (barks)	$0.80^{e} \pm 0.04$	$0.07^{h} \pm 0.01$	$20.03^{h} \pm 0.24$	$271.23^{j} \pm 6.70$	$93.14^{f} \pm 5.21$
5	*Coriandrum sativum* (seeds)	$0.73^{ef} \pm 0.03$	$0.30^{cd} \pm 0.02$	$24.92^{de} \pm 0.39$	$187.39^{m} \pm 6.70$	$67.96^{g} \pm 3.58$
6	*Curcuma longa* (rhizomes)	$0.30^{h} \pm 0.00$	$0.30^{cd} \pm 0.02$	$10.66^{j} \pm 0.27$	$373.92^{g} \pm 4.69$	$94.30^{ef} \pm 5.78$
7	*Emblica officinalis* (fruits)	$0.28^{h} \pm 0.02$	$0.22^{f} \pm 0.02$	$18.08^{i} \pm 0.34$	$596.78^{a} \pm 5.79$	$91.25^{f} \pm 3.58$
8	*Mentha spicata* (leaves)	$1.35^{d} \pm 0.02$	$0.42^{b} \pm 0.02$	$22.90^{g} \pm 0.19$	$579.79^{b} \pm 4.96$	$120.27^{cd} \pm 3.88$
9	*Moringa oleifera* (leaves)	$2.00^{b} \pm 0.00$	$0.30^{cd} \pm 0.01$	$30.44^{c} \pm 0.28$	$397.01^{f} \pm 3.94$	$112.62^{de} \pm 3.88$
10	*Murraya koenigii* (leaves)	$1.70^{c} \pm 0.11$	$0.13^{g} \pm 0.01$	$23.23^{fg} \pm 0.36$	$376.35^{g} \pm 6.35$	$133.97^{bc} \pm 4.99$
11	*Ocimum sanctum* (leaves)	$1.83^{bc} \pm 0.03$	$0.32^{c} \pm 0.01$	$22.25^{g} \pm 0.27$	$342.54^{h} \pm 5.98$	$106.67^{def} \pm 3.58$
12	*Phyllanthus niruri (*leaves)	$0.70^{ef} \pm 0.04$	$0.53^{a} \pm 0.01$	$24.24^{ef} \pm 0.50$	$448.09^{d} \pm 5.66$	$99.05^{ef} \pm 4.99$
13	*Piper nigrum* (seeds)	$0.50^{g} \pm 0.00$	$0.28^{cde} \pm 0.03$	$25.49^{d} \pm 0.48$	$196.00^{m} \pm 5.50$	$149.49^{b} \pm 9.71$
14	*Syzygium aromaticum (*buds)	$0.78^{e} \pm 0.03$	$0.27^{cde} \pm 0.03$	$32.56^{b} \pm 0.28$	$222.27^{l} \pm 2.75$	$286.96^{a} \pm 5.75$
15	*Trigonella foenum* (seeds)	$0.29^{h} \pm 0.03$	$0.38^{b} \pm 0.01$	$22.64^{g} \pm 0.60$	$199.59^{m} \pm 5.68$	$120.09^{c} \pm 5.74$
16	*Zingiber officinale (*dry rhizomes)	$0.30^{h} \pm 0.00$	$0.25^{def} \pm 0.02$	$18.04^{i} \pm 0.38$	$242.18^{k} \pm 4.68$	$143.70^{b} \pm 13.34$

*Mean of six observations.
Means bearing different superscripts within column differ significantly ($P < 0.05$)

Table 4. Saturated fatty acid (% of fat) content (Mean* ± S.E) of different herbs

S.No.	Name of the herb	Myristic acid	Palmitic acid	Palmitoleic acid	Stearic acid	Arachidic acid	Behenic acid
1	*Allium sativum* (bulbs)	Nil	$35.24^{a} \pm 0.93$	Nil	$19.61^{bd} \pm 0.12$	Nil	Nil
2	*Andrographis paniculata* (stem and leaves)	$2.18^{c} \pm 0.01$	$24.64^{b} \pm 0.04$	Nil	$7.28^{c} \pm 0.03$	Nil	$6.12^{f} \pm 0.14$
3	*Azadirachta indica* (leaves)	$4.24^{b} \pm 0.13$	$21.81^{c} \pm 0.31$	$1.49^{d} \pm 0.07$	$4.68^{cde} \pm 0.13$	Nil	$5.61^{g} \pm 0.04$
4	*Cinnamomum verum* (barks)	$1.20^{d} \pm 0.12$	$18.72^{f} \pm 0.35$	$1.62^{d} \pm 0.19$	$4.61^{dce} \pm 0.16$	Nil	$7.93^{e} \pm 0.04$
5	*Coriandrum sativum* (seeds)	$0.41^{e} \pm 0.04$	$5.31^{k} \pm 0.15$	$0.49^{f} \pm 0.06$	$0.82^{de} \pm 0.02$	$0.56^{b} \pm 0.01$	$0.45^{l} \pm 0.01$
6	*Curcuma longa* (rhizomes)	Nil	$6.63^{j} \pm 0.05$	$3.22^{b} \pm 0.03$	Nil	Nil	$10.24^{d} \pm 0.10$
7	*Emblica officinalis* (fruits)	Nil	$12.50^{h} \pm 0.07$	Nil	$4.85^{cde} \pm 0.03$	Nil	$10.73^{c} \pm 0.12$
8	*Mentha spicata* (leaves)	$1.25^{e} \pm 0.01$	$20.72^{d} \pm 0.35$	Nil	$6.71^{c} \pm 0.15$	Nil	$2.45^{i} \pm 0.06$
9	*Moringa oleifera* (leaves)	Nil	$19.59^{e} \pm 0.04$	$2.12^{c} \pm 0.12$	$5.58^{cd} \pm 0.19$	Nil	$8.20^{e} \pm 0.18$
10	*Murraya koenigii* (leaves)	Nil	$18.21^{f} \pm 0.07$	Nil	$5.95^{cd} \pm 0.07$	Nil	$11.48^{b} \pm 0.03$
11	*Ocimum sanctum* (leaves)	$0.55^{e} \pm 0.04$	$15.22^{g} \pm 0.08$	$1.51^{d} \pm 0.01$	$8.10^{c} \pm 0.09$	$1.20^{a} \pm 0.06$	$3.66^{h} \pm 0.16$
12	*Phyllanthus niruri* (leaves)	$13.82^{a} \pm 0.29$	Nil	Nil	$6.08^{cd} \pm 0.12$	Nil	$1.96^{j} \pm 0.03$
13	*Piper nigrum* (seeds)	Nil	$12.96^{h} \pm 0.30$	$6.60^{a} \pm 0.06$	$6.37^{cd} \pm 0.07$	Nil	$12.74^{a} \pm 0.12$
14	*Syzygium aromaticum* (buds)	Nil	$3.71^{l} \pm 0.07$	$0.78^{e} \pm 0.09$	$82.52^{a} \pm 0.14$	Nil	$0.86^{k} \pm 0.02$
15	*Trigonella foenum* (seeds)	$0.59^{e} \pm 0.01$	$10.29^{i} \pm 0.03$	Nil	$4.64^{cde} \pm 0.03$	Nil	$3.73^{h} \pm 0.05$
16	*Zingiber officinale* (dry rhizomes)	Nil	$20.77^{e} \pm 0.38$	Nil	Nil	Nil	$10.42^{d} \pm 0.18$

*Mean of six observations
Means bearing different superscripts within column differ significantly ($P < 0.05$)

Table 5. Unsaturated fatty acid (% of fat) content (Mean* ± S.E) of different herbs

S. No.	Name of the herb	Oleic acid	Linoleic acid	Linolenic acid
1	*Allium sativum* (bulbs)	$36.66^{b} \pm 0.11$	$8.86^{m} \pm 0.31$	Nil
2	*Andrographis paniculata* (stem and leaves)	$20.04^{e} \pm 0.02$	$20.22^{b} \pm 0.13$	$2.37^{j} \pm 0.03$
3	*Azadirachta indica* (leaves)	$15.60^{g} \pm 0.03$	$15.06^{f} \pm 0.05$	$20.96^{e} \pm 0.16$
4	*Cinnamomum verum* (barks)	$23.45^{c} \pm 0.28$	$20.44^{b} \pm 0.13$	$5.98^{i} \pm 0.35$
5	*Coriandrum sativum* (seeds)	$73.76^{a} \pm 0.09$	$14.79^{fg} \pm 0.09$	$0.91^{k} \pm 0.03$
6	*Curcuma longa* (rhizomes)	$8.66^{k} \pm 0.05$	$12.33^{j} \pm 0.16$	$21.26^{de} \pm 0.19$
7	*Emblica officinalis* (fruits)	$21.31^{d} \pm 0.33$	$19.38^{c} \pm 0.02$	$9.44^{g} \pm 0.08$
8	*Mentha spicata* (leaves)	$7.24^{m} \pm 0.02$	$13.61^{i} \pm 0.02$	$37.17^{b} \pm 0.09$
9	*Moringa oleifera* (leaves)	$10.15^{i} \pm 0.10$	$10.39^{l} \pm 0.13$	$14.44^{f} \pm 0.09$
10	*Murraya koenigii* (leaves)	$15.49^{g} \pm 0.10$	$16.10^{d} \pm 0.23$	$6.54^{h} \pm 0.17$
11	*Ocimum sanctum* (leaves)	$9.81^{ij} \pm 0.02$	$15.64^{e} \pm 0.06$	$25.28^{c} \pm 0.08$
12	*Phyllanthus niruri* (leaves)	$7.82^{l} \pm 0.34$	$11.87^{k} \pm 0.11$	$51.78^{a} \pm 0.39$
13	*Piper nigrum* (seeds)	$9.43^{j} \pm 0.10$	$14.58^{g} \pm 0.03$	$6.50^{hi} \pm 0.23$
14	*Syzygium aromaticum* (buds)	$2.24^{n} \pm 0.08$	$4.63^{n} \pm 0.03$	$0.59^{k} \pm 0.04$
15	*Trigonella foenum* (seeds)	$14.59^{h} \pm 0.08$	$36.43^{a} \pm 0.09$	$21.66^{d} \pm 0.01$
16	*Zingiber officinale (*dry rhizomes)	$17.88^{f} \pm 0.19$	$14.07^{h} \pm 0.22$	$9.10^{g} \pm 0.29$

*Mean of six observations.

Means bearing different superscripts within column differ significantly ($P < 0.05$)

Fatty acid profile

A high variability in the fatty acid profiles between herbal samples were observed. Wide variations in levels of saturated and unsaturated fatty acids have been detected in several studies on crop germplasm collections (Fernandez-Martinez *et al.,* 1993; Rebetzke *et al.,* 1998; Johnson *et al.,* 1999). Such variations offer possibilities to develop superior varieties with higher edible / specialized / industrial oils. The variability in the fatty acid composition is due to both genetic and weather factors (Goffman *et al.,* 2003; Mourtzinis *et al.,* 2017).

The major fatty acids in *A. sativum* bulb were similar to that reported by Yang and Hyo - sun (1982). Similar to the results of this study Kaushik and Vir (2000) also reported that neem oil contains palmitic, stearic, oleic and linoleic acids in good proportion. Hossain *et al*. (2015) reported that the saturated fatty acids present in the oil sample of *P. nigrum* seed were mainly myristic acid (8.26 %), lauric acid (26.93 %), palmitic acid (12.24 %), stearic acid (17.28 %) and lignoceric acid (4.00 %), these findings were contradictory to the present study where no myristic acid was detected in fat of *P. nigrum* seeds. In addition to eugenol, in *S. aromaticum* bud the other important fatty acids. chavicol, palmitic acid, malonic acid and stearic acid were reported by Rajalekshmy and Manimekalai (2019). In the present study, *S. aromaticum* also had high stearic acid content. *C. sativum* seeds in this study had the highest oleic acid, which was in accordance with Uitterhaegen *et al*. (2016) who reported that *C. sativum* seeds oil was rich in petroselinic acid, an uncommon positional isomer of oleic acid.

CONCLUSION

The study has documented several essential minerals and fatty acids in addition to the macro nutrients in the common herbs and their parts used for traditional medicine in Tamil Nadu. Further studies need to be carried out to quantify other bioactive compounds in these herbal samples, and to study their antioxidant and antimicrobial properties so that they could be used as alternatives to antibiotics / other drugs for livestock and poultry.

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