Assessment of variation in some medicinal plant species envisaged of having the potential for the preservation of herbal products using some statistical models

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Abstract

A survey research was conducted on some medicinal plant species envisaged of having the potential for preservation of herbal preparations. The aim was to determine whether there is an interspecific relationship among some selected medicinal plant species using their total extracts as the basis for computerization. To this end, statistical model comprising the Duncan's Multiple Range Test and Principal Component Analysis (PCA) were applied to the total extract obtained from the medicinal plant species harvested from Mampong - and Mamfe – Akuapem environs to determine the existence of variations. The results showed the existence of variation and some of the medicinal plant species were more influential or weighted more than others.

Keywords: Anti-microbial, preservative, principal component analysis.

Introduction

For centuries, plant-based medicaments have been man's prime therapeutic weapons and are still in the frontline for treating a large number of diseases. Furthermore, the deeper one goes into the study of plants used in traditional medicine, the more one perceives new possibilities for additional plant derivatives. Man's survival has been dependent on his inmate curiosity, his desire to examine by trial and error all aspects of his environs and conclude on which ones are harmful and which ones give him the greatest nourishment.

According to Saxena *et al.* (1994 and 1995), screenings of several medicinal plants in various laboratories have proved to have antimicrobial properties. The petroleum ether extract of the fruits of *Xylopia aethiopica* (Dunal) A. Rich is known to have antifungal properties as well as a wide-range of antibacterial activities as a results of the presence of xylopic acid (Abegaz *et al*., 1977; Boakye-Yiadom *et al*., 1977). Pruthi *et al*., (1980) also noted the prevention aspects of the ethanolic extracts of *Cinnamomnm zeylanium* on the growth of moulds, yeasts and bacteria. *Cinnamomnm zeylanium* and *Zanthoxylum xanthoxyloides* have been found to exhibit antimicrobial

properties (Anon. 1992). The aerial parts of the medicinal plant part of *Hoslundia opposita* is known to treat gonorrhooea, cystitis, hookworm, cough, fevers, colds, wounds and bilharzias (Chhabra and Uiso, 1994; Ngadjui *et al*., 1991; Hedberg *et al*., 1983). The alkaloidal extracts of *Annona crassiflora* Linn.have been reported to exhibit analgesic, spasmolytic and limited anti-bacterial effects (Hocquemiller *et al*., 1982). Extraction of the whole plant of *Cnestis ferruginea* is used to treat conjunctivitis, syphilis, gum pain, wounds, diarrhoea and dysentery (Bouquet and Debray, 1974; Le Grand, 1989). As stated in Ghana Pharmacopoiea (1992), *Psidium guajava* is used to manage acute and chronic diarrhoea in addition to *Herpes zoster*.

From the above plethora of medicinal plant species, which are used locally in some communities in Ghana for the preservation of decoctions, concoction and poultice, it could be envisaged that they could be used for the preservation of herbal products, in place of chloroform, which has carcinogenic effects. This has prompted researchers at the Centre for Scientific Research into Plant Medicine to screen a host of medicinal plants having the potential in promoting the shelf life of herbal products or preparations by assessing the level of variation using the weighting of the plant extracts.

According to Whang, *et al*., (2002), variation patterns at the species level and below are based on multivariate statistical methods. As observed by Sneath and Sokal (1973) multivariate analysis has proven useful in systematics, particularly at the species level and below, since it helps to approximate the scientific goals of objectivity, repeatability, flexibility and quantitatively.

Therefore, the research is aimed at establishing the interspecific variations among the plant species, using their total extracts through the application of the Duncan's Multiple Range Test and Principal Component Analysis.

Materials and methods

Collection site

The medicinal plants listed below were collected from the environs of Mampong-Akuapem and Mamfe-Akuapem in the Akuapem North, Esatern Region as well as Ayikuma in the Greater-Accra Region.

List of medicinal plant species

Plant species	Plant part used	Coding
Alchornea cordifolia (Schum.& Thonn.) Stapf	Leaves	ACl
Cinnamomum zeylanium Nees	Leaves	CVl

Clausena anisata (Will.) Hook.f.ex Benth	Root bark	CArb
Cryptolepis sanguinolenta (Lindl.) Schtr.	Root bark	CSrb
Cnestis ferruginea DC	Leaves	CFl
Hoslundia opposita Vahl	Leaves	HOl
Lippia multifolia Moldenke	Leaves	LMl
Morinda lucida Benth	Leaves	MLl
Ocimum gratissimum Linn.	Leaves	OGl
Psidium guajava Linn.	Leaves	PGl
Spondias mombin Linn.	Leaves	SMl
Tridax procumbens	Whole plant	TPwp
Xylopia aethiopica (Dunal) A. Rich	Fruits	XAf
Zanthoxylum xanthoxyloides (Lam.) Waterm	Root bark	ZXrb

Authenticity of the medicinal plants

Seasoned Botanists did the authentication of the medicinal plant species in the Herbarium of the Centre for Scientific Research into Plant Medicine. Voucher specimen of the plant species have been deposited in the Centre's Herbarium.

Experimental

Quantitative determination of total extracts

Quantitative determination of total extracts was carried out, five replicates were prepared for each plant organ per location and the mean value computed. The plant materials were air-dried for 30 days and ground to fine powder using the Manesty disintegrator. Equal quantities of 1000g of the powders obtained in each case were soxhlet extracted with hexane for 12 hours to defat the powdered plant materials. The defatted powder in each

case was taken and the alkaloid extracted with ethanol. The extracts were filtered and concentrated under

reduced pressure using a rotary evaporator. The residue was mixed with 200ml of 10% aqueous acetic acid and

allowed to stand overnight. The mixture was filtered with Whatman No. 1 filter paper. The filtrate was basified

to pH 10 with ammonium solution. The basic mixture was extracted with two equal volumes of 200ml of

chloroform. The chloroform extract was dried with anhydrous sodium sulphate and the solvent removed under

reduced pressure.

Statistical analysis

The Minitab 13.32 was fitted to the dataset to determine whether there is variation among the medicinal plant

species obtained from the sample locations. The Duncan's Multiple Range Test and Principal Component

Analysis were applied to assess the level of significant differences and weighting of the medicinal plant species,

respectively.

Results

The results presented in Tables 1 and 2 below, show the significant difference and weightings among the

medicinal plant species using Duncan's Multiple Range Test and the Principal Coponent Analysis (PCA).

Table 1: Showing levels of variation among the medicinal plant species using the Duncan's Multiple Range Test.

Name of plant species	Family	Local name	Plant part used	Total extraction (g)
Alchornea cordifolia	Euphorbiaceae	Agyamma, Gyeka, Gboo, Gbloo, Ahama	Leaves	28.30(g)
Cinnamomum zeylanium	Lauraceae	---------	Leaves	83.10 (b)
Clausena anisata	Rutaceae	Sesadua, Samanɔbere, Duawonsi, Ayira	Leaves	47.59 (c)
Cryptolepis sanguinolenta	Periploaceae	Nibima, Kadze, Gangamau	Root bark	19.68 (j)
Cnestis ferruginea	Connaraceae	Apɔsẽ, Akitase, Pudaegye	Leaves	18.43 (k)
Hoslundia opposita	Labiate	Aberewa-ani-nsu, Nunum-	Leaves	

		nini, Asifuaka, Akɔta		32.65 (f)
Lippia multifolia	Verbenaceae	Saanunum, Na suru, Afu-loti	Leaves	23.28 (i)
Monodora myristica	Annonaceae	Awerewa, wereɛ., Abotokuradua, Avonoba, Maalai, Yikwi	Seeds	18.06 (k)
Morinda lucida	Rubiaceae	Kɔnkroma	Leaves	32.43 (f)
Ocimum gratissimum	Labiate	Onumum, Suru, Sru,Gbekonɔ	Leaves	39.70 (e)
Psidium guajava	Myrtaceae	Oguawa, Eguaba, Gowa, Goa, Aduɔba	Root bark	99.66 (a)
Spondias mombin	Anacardiaceae	Atoaa, atawa, adontsho, toroma, adombaatsho	Leaves	6.16 (l)
Tridax procumbens			Whole plant	24.16 (h)
Xylopia aethiopica	Annonaceae	Hewentia, Soo, Tsuo	Fruit	47.40 (cd)
Zanthoxylum xanthoxyloides	Rutaceae	ɔKãntõ, Yea, Bɛbun, Kanfu, Haatɛo	Root bark	47.10 (d)

Principal Component Analysis was applied to the mean values of the plant extract. The 4 components that had eigenvalues that summed to > 1 were extracted (Table 2 below); therefore, the cut-off point was pegged on the 4th PC or eigenvalue. The results of the Scree plot in Fig. 1 show that fifteen (15) principal components were extracted or recorded; four Principal Components were considered acceptable although the elbow/change in slope is on the 10th Principal Component. This is because the total cumulation of the extracted components could accommodate 86.4% of variation in the original data (Fig. 1).
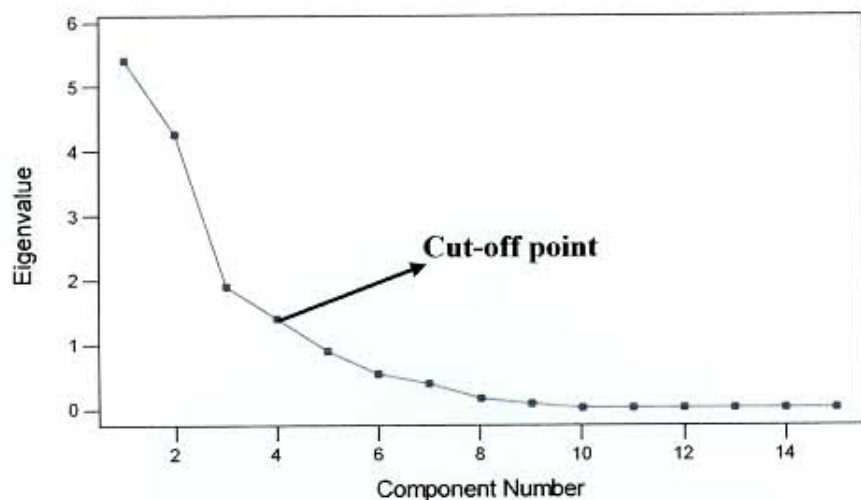
Fig. 1: A Scree plot showing the relationship between computational eigenvalues and component numbers based on the total extract of the medicinal plant species.

Table 2. Principal Component Analysis (PCA) rotated using varimax method based on the total extracts of the medicinal plant species converged in 15 iterations.

Plant species	PC 1	PC 2	PC 3	PC 4
ACl	0.080	0.383	-0.094	0.390
CZl	0.346	-0.016	-0.147	-0.093
CArb	-0.162	-0.436	-0.054	0.064
CSrb	-0.405	0.070	-0.120	-0.139
CFl	0.167	-0.339	0.092	-0.310
HOl	0.361	0.025	-0.024	-0.201
LMl	-0.047	0.175	-0.558	0.059
MMs	0.158	0.078	-0.610	0.070
MLl	0.169	-0.201	-0.437	-0.381
OGl	-0.405	0.070	-0.120	-0.139
PGrb	-0.405	0.070	-0.120	-0.139
SMl	-0.317	-0.040	-0.089	0.132
TPwp	0.135	-0.239	-0.068	0.649
XAf	-0.065	-0.450	-0.127	0.209
ZXrb	-0.131	-0.441	-0.110	0.072

Eigenvalue	5.4199	4.2637	1.8981	1.3845
Proportion	0.361	0.284	0.127	0.092
Cumulative	0.361	0.646	0.772	0.864

In Table 2 above, the cumulated percentage of variance under the Principal Component One (1) is 36.1. It implies that 36.1% of the primary variables have been extracted leaving a further 63.9%. This calls for further extraction of the variables leading finally to 86.4% of cumulated % of variances under the PC 4, which is expressed in the Table 2. In distinguishing high component, weights with values of 0.4 as their absolute value were arbitrarily adopted as the biological standard. From the above Table, the component or weights of *Cryptolepis sanguinolenta* (CSrb at - 0.405), *Ocimum gratissimum* (OGL at - 0.405) and *Psidium guajava* (PGrb at – 0.405) were the most influential variables in the first (1) principal component (PC1). In the second principal component (PC2), the component or weights of *Cinnamomum zeylanium* (CZrb at - 0.436), *Xylopia aethiopica* (Xaf at – 0.450) and *Zanthoxylum xanthoxyloides* (ZXrb at - 0.441) were also the most influential variables. In the third PC, *Lippia multifolia* (MLl at – 0.558) and *Monodora myristica* (MMs at – 0.610) were noted to be the influential plant species. Finally, *Tridax procumbens* (TPwp at 0.649) was the only influential plant species among the lot.

Discussion

The results in Table 1 prove that the plant extracts of the medicinal plant species were almost statistically variable. Results presented in Figs. 1 and Table 2 on the plant extracts indicate that some of the medicinal plant species can be rated as highly variable or weighted more than others. These led to change in slope or elbow of the Scree plots or the extraction of certain plant extracts more than others as expressed by the various Principal Component or factor loadings (PCs) above, which might have resulted from soil differences and environmental fluctuations as the main causative agents. Similar reports on the correlation weighting or discriminant of characters, have earlier been expressed by Whang, *et al*., (2002), Sneath and Sokal (1973).

Conclusion

Some of the characters were more influential or weighted more than others, although, all the characters were statistically, treated equally.

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