Research Article

Complementary and Alternative Medicines use for Gastro-Intestinal Disorders

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ABSTRACT

In today's medicine as many as one third to approximately half of all drugs available in the market are derived from plant or natural sources. This article deals with the use of quantitative ethno-botany for assessing potential and conservation priorities of the Indian Thar Desert Medicinal plants that are supposed to regulate the various disorders related with Gastro-Intestinal (GI) system. The study revealed that at least 90 plants of the region are so far documented for 18 different gastro-intestinal disorders and 11 other body systems. Relative Importance Value (RIV) of these 90 plants ranges from 90 to 13.3. Kolmogorov-Smirnov (K-S test) of frequency distribution revealed that out of these 90 plants some plants are highly useful with a broader RIV value while some plants are highly specific for a particular ailment. Agglomerative Hierarchical Clustering (AHC) of plants for their use in 11 different body systems has grouped them into 3 clusters, while Principal Component Analysis (PCA) highlights *Tamarindus indica* for their maximum usage for the diseases related with GI system. The higher usage of *Abutilon indicum, Sphaernthus indicus, Abrus precatorious, Solanum surattense, Sida codifolia, Clerodendrum phlomoides, Fumaria indica, Majorana hortensis* make them more vulnerable to degradation and requiring urgent conservation measures, including standardization of agro-techniques for their incorporation in cropping system to counter indiscriminate wild harvesting. Such multivariate analyses can provides a basic groundwork for preparation of multi-herb combination.

Keywords: Alternative and Complementary Medicine, Cluster Analysis, Gastro-Intestinal System, Principal Component Analysis, Quantitative Ethno-botany and Relative Importance Value

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INTRODUCTION

The term alternative and complementary medicine denote theories and practices of medicine which deviate from conventional, the former when they are used instead of, and the latter when they applied as an adjunct to standard management. The combined term alternative and complementary medicine encompasses a vast and heterogeneous range of diagnostic and therapeutic procedures as well as systematic and comprehensive concepts of health and diseases.

The digestive system can be affected by a wide diversity of acute and chronic diseases or conditions that, collectively, place a substantial burden on the healthcare system. Digestive diseases in general can affect individuals of any age, race or ethnicity, gender, or socioeconomic status, although some diseases disproportionately affect certain populations. Gastrointestinal (GI) disorders affect the esophagus, stomach, and small and large intestines. The most common are ulcers, acid reflux disease, and irritable bowel syndrome.

According to report of National Institute of Health, (2009), at least 60-70 million Americans are affected each year by digestive diseases at a cost that exceeds $100 billion in direct medical expenses. Annually, about 10 percent of hospitalizations and 15 percent of in-patient hospital procedures are attributed

to the treatment of digestive diseases. An additional 105 million visits to doctors' offices related to digestive diseases occur each year. These diseases are associated with significant mortality, morbidity, and loss of quality of life, and they frequently impact patients' ability to work or engage in everyday activities. More than $44 billion in indirect costs from disability and mortality are associated with digestive diseases each year. An estimated 15,000 deaths occur each year as a consequence of peptic ulcer disease (PUD). PUD is common in India, the Indian pharmaceutical industry have 6.2 billion rupees drugs share of antacids and antiulcer drugs and occupy 4.3% of the market share (Sharma et al., 2012).

Many patients use CAM for problems like irritable bowel syndrome, constipation, upset stomach or intestinal cancer. Patients with chronic or refractory gastrointestinal problems, such as functional gastrointestinal disorders (FGIDs) and inflammatory bowel disease (IBD) tend to use herbal products most frequently [1, 2]. Overall, 10% of herbal therapy is used for digestive symptoms and up to 30% of patients with chronic liver disease and 40% of patients with irritable bowel syndrome claim to have used some form of herbal medication in the past [3]. Recent studies indicate that the percentage of adult using CAM therapies for their gastro-intestinal symptoms ranges from 20 to 26%. In UK, 26% of patients with gastrointestinal symptoms sought complementary and alternative medicine therapy and 48% of those with irritable bowel syndrome (IBS) used CAM [4].

The therapy of functional gastro-intestinal disorders is one of the domains of phototherapeutic treatment [5]. Medicinal plants have therapeutic properties due to biosynthesis of various complexes phytochemical substance grouped broadly as phenolics, alkaloids and terpenoid. Traditionally, plants with high tannin content, showing astringent properties, were particularly valued to treat diarrhea and dysentery whereas bitter, aromatic and bitter-aromatic plants were especially employed to treat gastro-intestinal cramps and pain [6].

So far, relatively few herbal medicines have been evaluated scientifically to prove their safety, potential benefits and effectiveness in gastro-intestinal disorders [7]. Rahmathullah [8] were noted significant variation in the selection of medicinal plants used for treatment of gastrointestinal disorders by the Kavirajes of the four districts of Bangladesh. They have concluded that in each four district use of plants for gastro-intestinal disorders related with family specific. Sharma [9] reported the carminative and antacid effect of peeled crude extract of the *Citrullus lantus* fruit.

Several field studies on the ethno-knowledge of the local people have concluded that a single plant is useful for more than one disease related to different body systems [10]. This adds complexity to the system of data collection and processing at regional scale on the plant types useful for different health conditions. Since multivariate analysis is known to address the issues, the present study attempts to quantitatively evaluate the plants used mainly for treating disorders related to Gastrointestinal and other body systems, through such analysis.

A review of literature on the medicinal plants in Thar Desert revealed wealth of this part of country [11-15]. Ethnomedicinal surveys have been carried out in various district like Jodhpur, Barmer, Jaisalmer, Bikaner [10, 16- 22]. While agro-techniques have been developed for some plants like *Blepharis sindica, Pedalium murex, Corchorus depressus, Asparagus racemosus, Aloe vera* and *Withania somifera* [23- 26]. Conservation strategies for the medicinal plants have been discussed by [27-28]. Marketing and the trading potential [29-32] of different medicinal plants revealed that the highest trading was for Euphorbiaceae (1, 15,464kg/year) followed by Caesalpiniaceae (97,589kg/year) and Anacardiaceae (72,658kg/year), trade was for *Emblica officinalis* (1, 11,016 kg) followed by *Cassia angustifolia* (85,395kg) and *Mangifera indica*. (72,045kg). Advantage of quantitative ethno-botany in various subsectors of medicinal plants [33-36]. Incorporation of multivariate

techniques (PCA and AHC) for medicinal plants used by [37- 39].

OBJECTIVES

The objectives of the present study are (a) to quantify Relative Importance Value (RIV) of plants reported for gastrointestinal related diseases, (b) to assess conservation priorities with availability of their agro-techniques and their trading facilities, (c) to assess plant potential for treatment of diseases related to various body systems other than gastrointestinal disorders through agglomerative hierarchal cluster analysis, and (d) to group the plants based on their uses for various diseases related with gastrointestinal diseases by using Principal Component Analysis.

MATERIAL AND METHODS

The RIV for each medicinal plant was calculated accordingly Bennett and Prance [40]. This calculation was based on the normalized number of pharmacological properties attributed to it and the normalized number of body system (BS) it affects.

RI = ((R_{EL}.PH+ REL.BS) ÷ 2) X 100, Where

RI = Relative importance

R_{EL}.PH = Relative Number of Pharmacological Properties.

R_{EL}. BS = Relative Number of Body System Treated

The medicinal plant uses were classified into categories following the standard developed by Cook [41]. Research tally method of Boom [42] was utilized for quantitative evaluation of plant uses. Frequency distribution analysis was performed to find out the patterns among plants with their relative importance [43].

Multivariate analyses were performed with Statsoft [44] software. Agglomerative Hierarchal Cluster Analysis (AHC) was performed with the help of Ward method. The objective of cluster analysis is to develop sub grouping such that objects within a particular subgroup are more alike than those in a different sub-group. Principal Component Analysis (PCA) was carried out as a data reduction techniques. PCA is an ordination technique that constructs the theoretical variable that minimizes the total residual sum of squares after fitting straight lines to the data. PCA is also known as exploratory factor analysis and is data reduction technique designed to represent a wide range of attributes on a smaller number of dimensions. PCA was performed with Pearson correlation coefficient and the strength of correlation between variables was assessed by Bartlett's test of sphericity. For the above multivariate analysis, quantitative data set were prepared as suggested by [45-47].

RESULTS AND DISCUSSION

The gastrointestinal tract (GIT) consists of a hollow muscular tube starting from the oral cavity, where food enters the mouth, continuing through the pharynx, esophagus, stomach and intestines to the rectum and anus, where food is expelled. There are various accessory organs that assist the tract by secreting enzymes to help break down food into its component nutrients. Thus the salivary glands, liver, pancreas and gall bladder have important functions in the digestive system.

According to Houghton and Mukherjee, [5], gastrointestinal disorders can be categorized into (i) General GI disorders (Undiagnosed abdominal pain, Diarrhea, Constipation, Gas (flatulence), Heartburn, Fecal (stool) incontinence, Hemorrhoids, Internal and external haemorrhoids, Nausea/vomiting, Motility disorders and Melena). (ii) Esophagus Disease (Gastro-esophageal Reflux Disease (GERD), Barrett's Esophagus, Dysphasia, Achalasia ("failure to relax"). (iii) Disorders of the Bowel (Inflammatory Bowel Disease, Crohn's disease, Diverticulitis/Diverticulitis, Irritable bowel syndrome (IBS) and (IV) Diseases of the Stomach (Dyspepsia, Cyclical vomiting syndrome (CVS) Gastro paresis (stomach paralysis), Gastritis, ulcer and tumor.

From the vast array of Meteria Medica of the indigenous systems, many plants have been reported to have activity against various gastrointestinal disorders and to act as useful remedies for the alleviation of human suffering [48-49]. Several plants useful for the various gastrointestinal problems have been reviewed by [9, 49, 50-55]. These authors have discussed the potentiality of *Andrographis paniculata, Curcuma longa, Portulaca oleracea, Aloe barbadensis, Ceropegia hirsute, Citrullus*

qurantiifolia, Ficus racemosa, menthe longifolia, Plantago lanceolata, and *Glycyrrhiza glabra.* Kagyung [54] have reported 44 plant species, out of which 9 species use for stomachache, 6 species as stomachic, 4 species as carminative, 3 species as antiemetic, 2 species as anti-helmentic, 1 species each as anti-flatulent and laxative.

The present study revealed that 90 plants of the Thar Desert in Rajasthan, India, have been documented for 18 different disorders of gastrointestinal. In totality these 90 plants have been reported for their use in 12 different body system viz., skeletal muscle and connective tissues, respiration, skin and sub-cutanous system, digestion, endocrine gland, metabolism and nutrition, circulatory system, blood and hematopoietic organ, genitor-urinary system, central nervous system, sensory system, fever and reproduction.

The maximum relative importance was shown by *Aloe vera* (90.0) followed by *Achyranthies aspera* (84.2), *Azadirachta indica* (83.3) and *Sarcostemma acidum* (13.3) had the lowest RI. Approximately 42.22% species possessed RI >50 **(Table 1).**

Table 1: Relative Importance Value of Medicinal Plants in the Thar Desert. # PH = Number of Pharmacological Properties. R_{EL}.PH = Relative Number of Pharmacological Properties (Normalized to Maximum Value of 1). # BS = Number of Body Systems Treated. R_{EL}. BS = Relative Number of Body System Treated (Normalized to Maximum Value of 1). RI = Relative Importance ((R_{EL}.PH+ REL.BS) ÷ 2)x100.

	#PH	#BS	R_{EL}.PH	R_{EL}. BS	RI	Agro-techniques	Trading
Aloe vera	24	12	0.8	1.0	90.0	Y	Y
Achyranthies aspera	28	9	0.9	0.8	84.2	N	Y
Azadirachta indica	30	8	1.0	0.7	83.3	Y	Y
Boerhavia diffusa	22	10	0.7	0.8	78.3	N	Y
Ocimum sanctum	23	8	0.8	0.7	71.7	Y	Y
Terminalia arjuna	20	9	0.7	0.8	70.8	Y	Y
Asparagus racemosus	22	8	0.7	0.7	70.0	Y	Y
Solanum nigrum	21	8	0.7	0.7	68.3	Y	Y
Abutilon indicum	18	9	0.6	0.8	67.5	N	Y
Emblica officinalis	17	9	0.6	0.8	65.8	Y	Y
Eclipta prostrata	16	9	0.5	0.8	64.2	Y	Y
Moringa oleifera	16	9	0.5	0.8	64.2	Y	Y
Sphaeranthus indicus	18	8	0.6	0.7	63.3	N	Y
Vernonia cinerea	18	8	0.6	0.7	63.3	N	Y
Amaranthus spinosus	15	9	0.5	0.8	62.5	N	N
Withania somifera	15	9	0.5	0.8	62.5	Y	Y
Abrus precatorious	17	8	0.6	0.7	61.7	N	Y
Hibiscus rosa-sinensis	17	8	0.6	0.7	61.7	Y	Y
Vitex negundo	17	8	0.6	0.7	61.7	Y	Y
Solanum surattense	16	8	0.5	0.7	60.0	N	Y
Datura mental	18	7	0.6	0.6	59.2	Y	Y
Aegel marmelos	15	8	0.5	0.7	58.3	Y	Y
Cassia fistula	17	7	0.6	0.6	57.5	Y	Y
Commiphora wightii	17	7	0.6	0.6	57.5	Y	Y
Sida cordifolia	12	9	0.4	0.8	57.5	N	Y
Vetiveria zizanoides	12	9	0.4	0.8	57.5	Y	Y
Agemone mexicana	19	6	0.6	0.5	56.7	N	Y
Butea monosperma	14	8	0.5	0.7	56.7	Y	Y

Ricinus communis	14	8	0.5	0.7	56.7	Y	Y
Euphorbia caducifolia	13	8	0.4	0.7	55.0	Y	Y
Cocculus hirsutus	12	8	0.4	0.7	53.3	N	Y
Tinospora cordifolia	12	8	0.4	0.7	53.3	Y	Y
Ficus religiosa	14	7	0.5	0.6	52.5	Y	Y
Calotropis procera	16	6	0.5	0.5	51.7	N	Y
Tephrosia purpurea	16	6	0.5	0.5	51.7	Y	Y
Tianthema portulacastrum	11	8	0.4	0.7	51.7	N	N
Boswellia serrata	18	5	0.6	0.4	50.8	Y	Y
Holarrhina antidysentrica	13	7	0.4	0.6	50.8	Y	Y
Andrographic paniculata	10	8	0.3	0.7	50.0	Y	Y
Echinops echinatus	10	8	0.3	0.7	50.0	N	N
Mucuna pruriens	10	8	0.3	0.7	50.0	Y	Y
Trigonella foenum graecum	15	6	0.5	0.5	50.0	Y	Y
Ziziphus mauritiana	15	6	0.5	0.5	50.0	Y	Y
Clemoe viscosa	12	7	0.4	0.6	49.2	N	Y
Evovulus alsinoides	12	7	0.4	0.6	49.2	Y	Y
Glycyrrhiza glabra	12	7	0.4	0.6	49.2	Y	Y
Peganum harmala	12	7	0.4	0.6	49.2	Y	Y
Tamarindus indica	17	5	0.6	0.4	49.2	Y	Y
Cynodon dactylon	14	6	0.5	0.5	48.3	Y	y
Cardiospermum halicacabum	11	7	0.4	0.6	47.5	Y	Y
Salvadora persica	13	6	0.4	0.5	46.7	Y	Y
Saccgaraum spontaneum	10	7	0.3	0.6	45.8	Y	Y
Cissus quadrangularis	12	6	0.4	0.5	45.0	Y	Y
Adhatoda vasica	14	5	0.5	0.4	44.2	Y	Y
Citrullus colocynths	11	6	0.4	0.5	43.3	Y	Y
Clerodendrum phlomoides	11	6	0.4	0.5	43.3	N	Y
Cyperus rotundus	11	6	0.4	0.5	43.3	Y	Y
Murraya koenigii	11	6	0.4	0.5	43.3	N	N
Fumaria indica	8	7	0.3	0.6	42.5	N	Y
Urginea indica	13	5	0.4	0.4	42.5	N	N
Catharanthus roseus	10	6	0.3	0.5	41.7	Y	Y
Albizia lebbeck	12	5	0.4	0.4	40.8	Y	Y
Balanites aegyptiaca	12	5	0.4	0.4	40.8	Y	Y
Acacia senegal	9	6	0.3	0.5	40.0	Y	Y
Phyllanthus fraternus	11	5	0.4	0.4	39.2	Y	Y
Punica granatum	13	4	0.4	0.3	38.3	Y	Y
Aristolochia bracteolata	10	5	0.3	0.4	37.5	Y	Y
Cassia occidentalis	10	5	0.3	0.4	37.5	Y	Y
Jatropha curcas	12	4	0.4	0.3	36.7	Y	y
Tribulis terrestris	12	4	0.4	0.3	36.7	Y	Y
Euphorbia hirta	9	5	0.3	0.4	35.8	Y	Y
Majorana hortensis	9	5	0.3	0.4	35.8	N	Y
Pergularia daemia	9	5	0.3	0.4	35.8	N	N

Cassia angustifolia	11	4	0.4	0.3	35.0	Y	Y
Maytenus emarginata	8	5	0.3	0.4	34.2	N	Y
Corchorus depressus	7	5	0.2	0.4	32.5	Y	Y
Fagonia indica	7	5	0.2	0.4	32.5	N	Y
Pedalium murex	9	4	0.3	0.3	31.7	Y	Y
Tylophora indica	8	4	0.3	0.3	30.0	Y	Y
Opuntia elatior	5	5	0.2	0.4	29.2	Y	Y
Mimosa pudica	7	4	0.2	0.3	28.3	Y	Y
Plantago ovata	8	3	0.3	0.3	25.8	Y	Y
Citrullus lanatus	5	4	0.2	0.3	25.0	Y	Y
Mollugo cerviana	5	4	0.2	0.3	25.0	Y	Y
Prosopis cineraria	5	4	0.2	0.3	25.0	Y	Y
Convolvulus microphyllus	3	3	0.1	0.3	17.5	Y	Y
Zygophyllum simplex	4	2	0.1	0.2	15.0	N	N
Polygela senega	4	2	0.1	0.2	15.0	N	Y
Cucumis callosus	3	2	0.1	0.2	13.3	Y	Y
Sarcostemma acidum	3	2	0.1	0.2	13.3	N	Y

Conservation priorities of these plants were assessed by identification of their cultivation practices if any, and their trading facilities. Based on these two parameters the 90 plants can be grouped under three categories. Category 1 includes 22 plants have both well developed agro-techniques as well as having well organized market for their trading (**Table 1**). Category 2 includes 7 plants; neither have agro-techniques nor trading facilities (RIV = 62.5-15.0). Category 3 includes 19 plants which, although having well established market, are still not having any agro techniques. From the conservation point of view the category 3 plants are important. These plants possess RIV ranging from 84.2 to 13.3. Although some of the plants like *Achyranthies aspera Boerhavia diffusa* and *Calotropis procera* are largely available on wastelands or along road sides, the plants like *Abutilon indicum, Sphaernthus indicus, Abrus precatorious, Solanum surattense, Sida codifolia Clerodendrum phlomoides Fumaria indica, Majorana hortensis* and *Sarcostemma acidum* have restricted distribution [56 - 57].

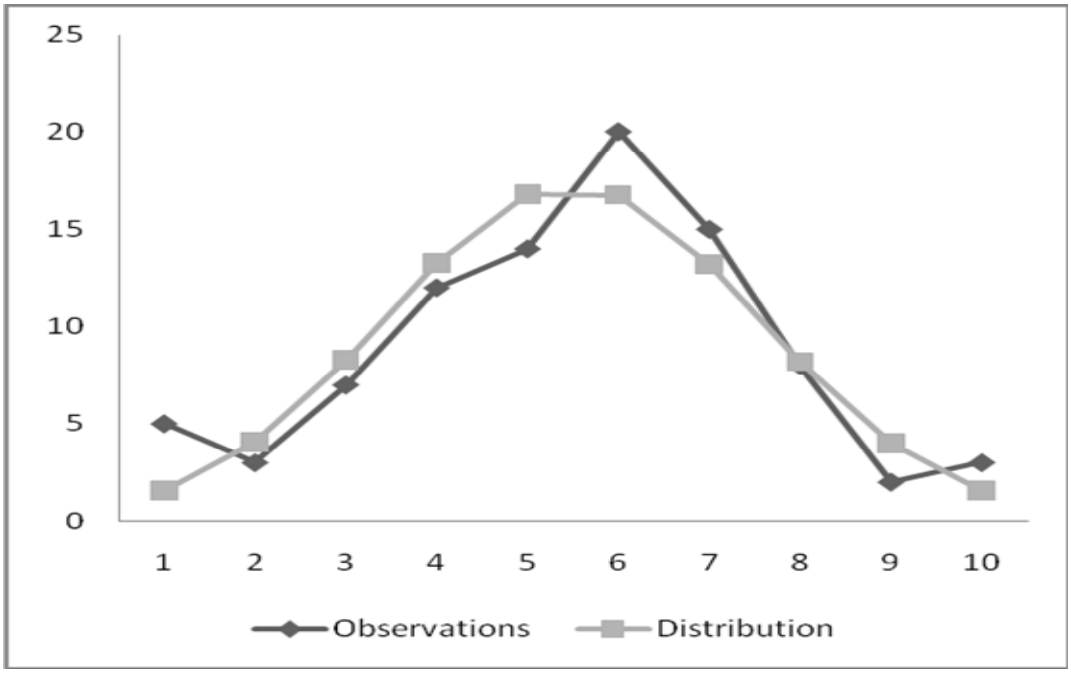
FREQUENCY DISTRIBUTIONS

Frequency distribution classifies the 90 plants in to 10 classes. Class 6 consists maximum number of plants (20) whose RIV ranging from 47.66 to 55.12 **(Figure 1),** followed by classes 7 with 15 plants (RIV = 55.12 to 62.64). In a normal distribution the value of skewness and kurtosis are equal or approximate zero. In present investigation the value of skewness (-0.117) and Kurtosis (-0.151) indicates normal distribution of RIV. This further proved by Kolmogorov-Smirnov (K-S test). It's a non parametric test for the equality of continuous, one-dimensional probability distribution that can be used to compare a sample with a reference probability distribution. In the present investigation as the p value (0.735) is greater than the significance level alpha = 0.05, that indicates the sample follows the normal distribution **(Table 2).** This distribution analysis revealed that out of these 90 plants some plants are highly useful with a broader RIV value while some plants are highly specific for a particular ailment.

Table 2: Frequency Distribution Parameters

Normal Distribution Parameters		**Koimogorav-Smirnov Test**	
Skewness	**Kurtosis**	**P-Value**	**Alpha**
-0.117	-0.151	0.735	0.05

Figure 1: Observed and Theroritcal Frequncies



AGGLOMERATIVE HIERARCHAL CLUSTER ANALYSIS (AHC)

Cluster analysis attempts to subdivide or partition a set of heterogeneous objects into relatively homogenous groups. The objective of cluster analysis is to develop sub grouping such that objects within a particular subgroup are more alike than those in a different subgroup. Agglomerative Hierarchal Cluster analysis was performed by Ward method with the help of Euclidean distance. Hierarchical clustering do not only cluster sample, but also cluster the various clusters that were formed earlier in the clustering process. Agglomerative clustering algorithms start by treating each sample or variable as a cluster of 1. The closest two clusters are joined to form a new cluster. For present investigation quantitative data set for 11 body systems and 90 plants were utilized **(Table 3).** In present study AHC grouped the heterogeneous variables into three different groups or clusters and within class variance revealed **(Table 4 and Figure 2)** that cluster one although possessed only two system but their within class variance approached maximum (170) designate it as most heterogeneous group. On the other hand cluster 2 consists 8 systems with 59.07 within class variance. Skin and sub-cutanous system was the most different among other body systems.

Such types of classification are useful for production of multi-herb and this statement is supported by finding that during 2001-2010 most Indian patent claimed for herbal drugs and on multi-herb composition [58].

PRINCIPAL COMPONENT ANALYSIS (PCA)

PCA is an ordination technique that constructs the theoretical variable that minimizes the total residual sum of squares after fitting straight lines to the data [59] PCA is also known as exploratory factor analysis and it's a data reduction techniques designed to represent a wide range of attributes on a smaller number of dimensions. There are several other statistics associated with the factor analysis out of which Bartlett's test of sphericity is one of them. It's used to examine the hypothesis that the variables are uncorrelated in the population.

For PCA the uses of the 90 plants for disease related with 18 different gastro-intestinal diseases were catalogued in binary system (**Table 5**). Column analysis revealed that among 90 plants, 23 plants were useful for only one specific disease, like *Acacia senegal* for Refrigerant, *Colligonum polygonoides* and *Catharanthus* roseus for emetic, *Citrullus lantus* and *Maytenus emarginata* as appetizer, *Commiphora wighhtii, Opuntia*

elator and *Datura Mental* for treatment of ulcer, *Convolvulus microphyllus* and *Fumaria indica* as laxative, *Chorcorus depressus* and *Jatropha curcas* as anti-dysenteric, *Echinops echinatus* for treatment of constipation, *Phyllanthus* fratneus and *Mollugo cervina* as anodyne, *Sarcostemma acidum, S. spontaneum* and *Morria oleifera* as anti-helminitic. 11 plants use for 2 disease, 17 plants useful for 3 different disease, 16 plants for 4 diseases, 14 plants for 5 and 8 plants for 6 diseases, while *Tamarindus indica* useful for 8 different disease related with gastro-intestinal disease. **(Table 5).** Thus from this analysis a particular plant can be selected for a particular disorder, or a specific plant can be selected for treatment of combination of various disorders.

Row wise analysis revealed that most of the plants are useful as anti-dysenteric (28), in diarrhea (27), as anti-helmintic and ulcer (25) however, only six plants are useful as anti-vomiting. The PCA analysis was performed with the use of Pearson correlation coefficient. The interpretation of the correlation circle was carried out under following criteria, when two variables are far from the center, then if they are: close to each other, they are significantly positively correlated (r close to 1); if they are orthogonal, they are not correlated (r close to 0); if they are on opposite side of the center, then they are significantly negatively correlated (r close to -1). Squared cosines were used to link the variable with the corresponding axis and the greater the squared cosine, the greater the link with the corresponding axis **(Figure 3 and 4).**

The Result of Bartlett's test of sphericity given in (**Table 6)**. There are two levels to interpret this test 1. H0: There is no correlation significantly different from 0 between the variables and 2, Ha: At least one of the correlations between the variables is significantly different from 0. As the computed p-value is greater than the significance level alpha=0.05, one cannot reject the null hypothesis H0. Here it can be said that the there are significant correlations between variables and their correlation matrix presented in (**Table 7).** .Matrix revealed significant positive relation between emetic +anodyne, anti-helminitc+ appetizer, refrigent+ colitis, diarrhea +anti-dysenteric, anti-dysenteric + anti-vomiting, anti-dysenteric + carminative, laxative + appetizer, constipation + emollient, dyspepsia +flatulence, dyspepsia + colitis, carminative + flatulence and carminative +colitis. Thus such types of combinations may be helpful for synthesis of multi-targeted herbal formulation.

CONCLUSION

Tiwari [60]. have assessed the therapeutic effect of New Diarex that consisting *Aegel marmalos, Punica granatum, Cyprus rotundas* and *Holarrhena antidysentrica.* They have clinically concluded that this herbal formulation have potential to treat the irritable bowel syndrome. Similarly Ali and Palaniyamma [61] have evaluated the pharmacokinetic properties of Gasex tablets. They have conducted a meta-analysis of 17 published clinical studies of Gasex. They reported that this herbal formulation normalizes the intestinal transit time and it has prebiotic, anti-flatulent, anti-ulcer, anti-inflammatory, hepato-protective effects. They have concluded that efficacy of Gasex attributed by synergistic action of the potent gastro-intestinal herbs like *Aconitum palmatum, Piper nigrum, and Embelia ribes.*

Sahoo [58], have analyzed the patterns of herbal patenting in India and they found that during 2001-2010, 12 Indian patent applications were filled for digestive disorders and out of 12, 10 patents were granted. Thus such trends indicate the importance of the traditional knowledge for preparing a novel composition for gastro-intestinal disorders.

Table 3: Number of Body systems treated by each species other then gastro-intestinal disorders

Plant Species	Respiration	Reproduction	Fever	Blood and Hematopoietic Organ	Central Nervous System	Genito-Urinary System	Circulatory System	Sensory System	Endocrine Gland, Metabolism and Nutrition	Skin and Sub-Cutanuous System	Skeletal, Muscle and Connective Tissues
Abrus precatorious	2	3	1	0	1	1	0	0	0	4	3
Abutilon indicum	1	3	2	0	2	1	0	1	0	1	2
Acacia senegal	2	0	1	0	0	0	0	1	0	2	2
Achyranthies aspera	5	3	0	1	3	2	0	1	0	3	4
Adhatoda vasica	5	0	0	0	1	0	0	0	0	1	2
Aegel marmelos	2	0	2	1	1	0	0	1	0	1	1
Albizia lebbeck	0	0	0	0	2	0	0	2	0	5	2
Aloe vera	1	2	1	1	1	1	0	2	1	2	6
Amaranthus spinosus	1	1	1	1	1	1	0	0	0	3	3
Andrographic paniculata	1	1	2	1	1	0	0	0	1	0	1
Aregemone mexicana	4	0	2	0	0	0	0	3	0	4	3
Aristolochia bracteolata	0	1	1	0	0	0	0	0	0	2	2
Asparagus racemosus	4	4	0	0	2	2	1	1	0	0	4
Azadirachta indica	2	0	4	1	0	1	0	4	0	9	5
Balanites aegyptiaca	1	2	0	0	0	0	0	0	0	4	1
Boerhavia diffusa	1	1	3	1	2	2	1	2	0	0	4
Boswellia serrata	5	0	0	0	0	1	0	0	0	2	5
Butea monosperma	1	2	1	1	0	1	0	0	0	2	3
Calligonum polygonoides	1	0	0	0	0	0	0	1	0	0	1
Calotropis procera	5	0	1	0	2	0	0	1	0	0	4
Cardiospermum halicacabum	0	1	0	0	3	1	0	1	0	2	2
Cassia angustifolia	1	0	0	0	0	0	0	0	0	3	2

Cassia fistula	1	0	3	1	1	0	0	0	0	4	3
Cassia occidentalis	0	1	1	0	0	1	0	0	0	4	0
Catharanthus roseus	2	1	0	3	1	2	0	0	0	0	0
Cissus quadrangularis	0	1	0	1	1	0	0	0	0	2	1
Citrullus colocynths	0	0	2	0	1	1	0	1	0	0	2
Citrullus lanatus	0	1	0	0	1	1	0	0	0	0	1
Clemoe viscosa	0	0	1	0	0	1	1	1	1	0	2
Clerodendrum phlomoides	0	0	1	0	0	1	1	0	0	1	2
Cocculus hirsutus	0	2	1	1	0	1	0	1	0	1	2
Commiphora wightii	4	0	0	4	0	1	0	0	1	3	3
Convolvulus microphyllus	0	0	0	0	1	0	0	0	0	0	1
Corchorus depressus	0	3	0	1	0	0	0	0	1	0	1
Cucumis callosus	0	0	0	0	0	0	0	0	0	0	1
Cynodon dactylon	1	0	0	0	0	2	0	3	0	2	3
Cyperus rotundus	0	1	0	0	0	1	0	1	0	1	2
Datura mental	3	1	1	0	0	0	2	1	0	4	5
Echinops echinatus	2	2	0	0	1	1	0	1	0	1	1
Eclipta prostrate	3	1	1	1	1	0	0	0	1	3	2
Emblica officinalis	2	0	0	3	0	1	1	1	0	0	5
Euphorbia caducifolia	2	1	1	1	1	0	0	0	0	3	2
Euphorbia hirta	3	1	0	0	0	0	0	0	0	3	1
Evovulus alsinoides	2	2	1	0	1	0	0	0	0	2	2
Fagonia indica	1	0	1	1	0	0	0	0	0	2	0
Ficus religiosa	2	1	1	2	0	0	1	0	0	2	0
Fumaria indica	0	0	2	1	0	1	0	1	1	1	0
Glycyrrhiza glabra	3	0	0	1	0	1	0	0	1	3	1
Hibiscus rosa-sinensis	1	5	1	0	0	1	2	0	0	2	4
Holarrhina antidysentrica	4	1	0	0	1	0	0	0	1	1	1

Jatropha curcas	0	0	0	2	0	0	0	0	0	4	5
Majorana hortensis	3	0	0	1	0	1	0	0	0	0	3
Maytenus emarginata	0	0	1	3	0	0	0	0	1	0	2
Mimosa pudica	1	0	0	0	0	1	0	0	0	2	0
Mollugo cerviana	0	0	0	2	0	0	0	0	0	1	1
Moringa oleifera	1	1	0	1	3	1	1	0	1	0	6
Mucuna pruriens	0	1	0	0	2	1	1	0	0	1	2
Murraya koenigii	0	0	0	1	2	1	0	1	0	2	0
Ocimum sanctum	5	0	2	0	3	1	0	2	0	2	3
Opuntia elatior	1	1	0	0	0	0	0	1	0	0	1
Pedalium murex	0	4	0	0	1	2	0	0	0	0	0
Peganum harmala	1	1	1	0	2	0	0	0	0	2	2
Pergularia daemia)	2	2	0	0	0	0	0	0	0	1	1
Phyllanthus fraternus	0	0	3	0	0	2	0	0	0	3	2
Plantago ovata	0	2	0	0	0	0	0	0	0	0	1
Polygela senega	3	0	0	0	0	0	0	0	0	0	0
Prosopis cineraria	0	1	0	0	1	0	0	0	0	0	2
Punica granatum	4	1	0	0	0	0	0	0	0	0	2
Ricinus communis	0	1	0	1	1	0	0	2	1	4	1
Saccgaraum spontaneum	2	1	0	0	1	1	0	0	0	1	3
salvadora persica	0	0	0	0	0	0	0	0	0	0	1
Sarcostemma acidum	2	1	1	1	1	1	0	0	0	1	1
Sida cordifolia	2	1	1	0	0	1	0	0	2	6	3
solanum nigrum	4	0	0	1	1	1	0	0	1	1	3
solanum surattense	1	2	1	1	0	0	3	2	0	2	0
Sphaeranthus indicus	1	0	3	0	0	0	0	1	0	0	3
Tamarindus indica	2	0	0	0	0	2	0	0	1	2	3
Tephrosia purpurea	0	0	1	1	1	1	0	1	1	0	3

Tinospora cordifolia	0	0	1	0	1	2	0	1	1	1	1
Tianthema portulacastrum	0	2	0	0	0	3	0	0	0	0	4
Tribulis terrestris	1	0	2	1	0	0	0	0	0	1	6
Trigonella foenum graecum	3	0	0	0	0	0	0	0	0	1	1
Tylophora indica	3	0	0	0	0	0	1	0	0	4	4
Urginea indica	1	0	2	1	0	1	0	2	0	5	1
Vernonia cinerea	2	0	2	0	2	1	0	0	1	1	6
Vitex negundo	3	1	1	1	3	1	0	0	0	1	3
Vetiveria zizanoides	4	1	1	1	0	0	0	0	0	0	3
Withania somifera	0	0	0	0	0	0	0	3	0	0	0
Ziziphus mauritiana	1	0	1	1	1	1	1	0	0	1	2
Saccgaraum spontaneum	0	1	1	2	1	1	0	0	0	0	2

Table 4: Results of Agglomerative Hierarchical Cluster Analysis (Coloum wise)

Class	**1**	**2**	**3**
Objects	2	8	1
Sum of weights	2	8	1
Within-class variance	170.500	59.071	0.000
Minimum distance to centroid	9.233	5.618	0.000
Average distance to centroid	9.233	7.083	0.000
Maximum distance to centroid	9.233	9.503	0.000
	Respiration	Reproduction	**Skin and Sub-Cutanuous System**
	Skeletal, Muscle and Connective Tissues	Fever	
		Blood and Hematopoietic Organ	
		Central Nervous System	
		Genito-Urinary System	
		Circulatory System	
		Sensory System	
		Endocrine Gland, Metabolism and Nutrition	

Bold letters represents the system, which are the central observation of the cluster analysis

Table 5: Species useful for various gastro-intestinal disorders treated

	Species name	Emetic	Purgative	Anti-helminitc	Demulcent	Ulcer	Refrigerant	Diarrhea	Anti-dysentric	Anodyne	Laxative	Constipation	Dyspespia	Appetizer	Carminative	Flatulence	Colities	Ant-vomiting	Emollient
1	*Abrus precatorious*	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	*Abutilon indicum*	0	0	1	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0
3	*Acacia senegal*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
4	*Achyranthies aspera*	0	0	0	0	0	0	1	1	1	1	0	1	0	0	1	0	0	0
5	*Adhatoda vasica*	0	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0
6	*Aegel marmelos*	0	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	0	1
7	*Albizia lebbeck*	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
8	*Aloe vera*	0	1	1	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0
9	*Amaranthus spinosus*	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0
10	*Andrographic paniculata*	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1
11	*Aregemone mexicana*	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0
12	*Aristolochia bracteolata*	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
13	*Asparagus racemosus*	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1
14	*Azadirachta indica*	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
15	*Balanites aegyptiaca*	0	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
16	*Boerhavia diffusa*	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0
17	*Boswellia serrata*	0	0	0	0	1	0	1	1	0	0	0	1	1	0	0	0	0	0
18	*Butea monosperma*	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1
19	*Calligonum polygonoides*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	*Calotropis procera*	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
21	*Cardiospermum halicacabum*	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
22	*Cassia angustifolia*	0	1	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
23	*Cassia fistula*	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
24	*Cassia occidentalis*	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
25	*Catharanthus roseus*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	*Cissus quadrangularis*	0	0	1	0	0	1	0	0	0	0	0	1	0	1	1	1	0	0
27	*Citrullus colocynths*	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
28	*Citrullus lanatus*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
29	*Clemoe viscosa*	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	1	0	0

30	*Clerodendrum phlomoides*	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0
31	*Cocculus hirsutus*	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0
32	*Commiphora wightii*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
33	*Convolvulus microphyllus*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
34	*Corchorus depressus*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
35	*Cucumis callosus*	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
36	*Cynodon dactylon*	0	0	1	1	0	0	1	0	0	0	0	1	0	1	0	0	1	0
37	*Cyperus rotundus*	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0
38	*Datura mental*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
39	*Echinops echinatus*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
40	*Eclipta prostrate*	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
41	*Emblica officinalis*	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0
42	*Euphorbia caducifolia*	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
43	*Euphorbia hirta*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
44	*Evovulus alsinoides*	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
45	*Fagonia indica*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
46	*Ficus religiosa*	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0
47	*Fumaria indica*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
48	*Glycyrrhiza glabra*	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
49	*Hibiscus rosa-sinensis*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	*Holarrhina antidysentrica*	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0
51	*Jatropha curcas*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
52	*Majorana hortensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
53	*Maytenus emarginata*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
54	*Mimosa pudica*	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0
55	*Mollugo cerviana*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
56	*Moringa oleifera*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	*Mucuna pruriens*	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
58	*Murraya koenigii*	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0
59	*Ocimum sanctum*	0	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0
60	*Opuntia elatior*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
61	*Pedalium murex*	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1
62	*Peganum harmala*	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

63	*Pergularia daemia)*	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
64	*Phyllanthus fraternus*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
65	*Plantago ovata*	0	0	0	0	0	0	1	0	0	1	1	1	1	0	0	0	0	0
66	*Polygela senega*	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
67	*Prosopis cineraria*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	*Punica granatum*	0	0	0	1	0	0	1	1	1	0	0	1	0	0	0	1	0	0
69	*Ricinus communis*	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
70	*Saccgaraum spontaneum*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
71	*salvadora persica*	0	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
72	*Sarcostemma acidum*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	*Sida cordifolia*	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0
74	*solanum nigrum*	0	0	0	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0
75	*solanum surattense*	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0
76	*Sphaeranthus indicus*	0	0	1	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0
77	*Tamarindus indica*	0	1	0	0	0	0	1	1	0	1	0	1	1	1	1	0	0	0
78	*Tephrosia purpurea*	0	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	0
79	*Tinospora cordifolia*	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
80	*Tianthema portulacastrum*	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1
81	*Tribulis terrestris*	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
82	*Trigonella foenum graecum*	0	0	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0
83	*Tylophora indica*	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
84	*Urginea indica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
85	*Vernonia cinerea*	0	0	1	0	0	0	1	0	1	0	0	1	1	0	0	0	1	0
86	*Vitex negundo*	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0
87	*Vetiveria zizanoides*	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0
88	*Withania somifera*	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0
89	*Ziziphus mauritiana*	1	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0
90	Saccgaraum spontaneum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6: Results of Bartlett's test of sphericity

Chi-square (Observed value)	209.119
Chi-square (Critical value)	182.865
DF	153
p-value	0.002
Alpha	0.05

Table 7: Correlation Matrix between variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Emetic 1																		
Purgative 2	0.00																	
Anti-helminit 3	-0.14	0.19																
Demulcent 4	-0.14	-0.20	-0.10															
Ulcer 5	-0.14	0.00	-0.11	0.05														
Refrigerant 6	-0.13	0.00	0.10	-0.03	0.02													
Diarrhea 7	0.00	-0.15	0.03	0.03	-0.03	-0.08												
Anti-dysentric 8	0.07	-0.10	-0.04	-0.05	0.07	0.14	**0.24**											
Anodyne 9	-0.18	**0.24**	0.12	-0.11	-0.12	0.09	0.04	0.02										
Laxative 10	-0.07	-0.09	-0.16	-0.01	-0.03	-0.07	0.20	0.06	0.06									
Constipation 11	-0.13	0.09	0.10	-0.14	0.10	-0.13	-0.08	-0.01	0.09	0.11								
Dyspespia 12	-0.12	0.04	0.11	-0.07	-0.01	-0.12	0.14	0.18	0.17	0.07	-0.04							
Appetizer 13	0.03	0.00	**-0.21**	-0.09	-0.08	-0.16	0.16	0.09	-0.07	**0.26**	-0.06	0.16						
Carminative 14	-0.15	0.17	0.14	0.01	0.01	0.04	0.05	**-0.22**	0.02	-0.12	0.04	0.18	-0.03					
Flatulence 15	-0.13	-0.02	0.07	-0.15	-0.08	-0.02	0.13	-0.03	0.07	0.09	-0.02	**0.34**	-0.08	**0.40**				
Colities 16	0.00	-0.07	0.12	-0.02	0.12	**0.35**	-0.06	-0.06	0.02	-0.06	0.00	**0.24**	-0.15	**0.27**	0.10			
Ant-vomiting 17	-0.09	-0.13	0.13	0.03	-0.07	-0.09	**0.21**	0.01	-0.02	-0.12	0.05	0.16	0.00	0.01	-0.10	-0.09		
Emollient 18	-0.13	0.09	0.18	0.07	0.02	0.10	0.00	0.07	-0.09	-0.07	**0.21**	-0.12	-0.16	-0.15	-0.13	-0.12	-0.09	0.00

Values in bold are different from 0 with a significance level alpha=0.05

Figure 2: Agglomerative Hierarchical Cluster Analysis of various body systems

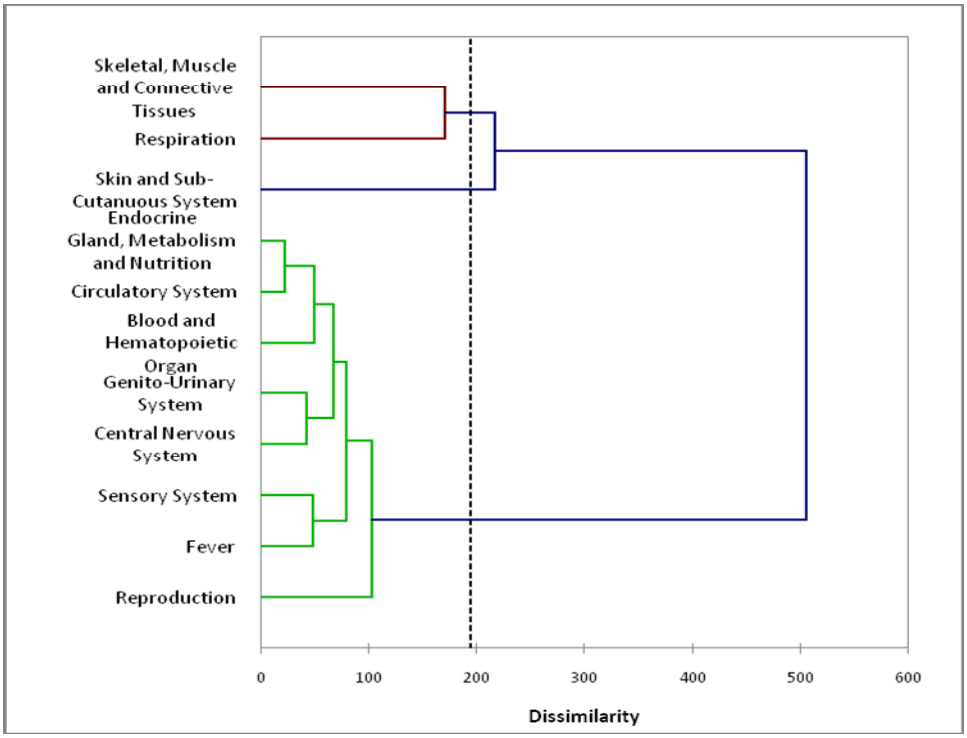


Figure 3: Principal Component Analysis (PCA) of various disorders related with Gastro- intestinal system

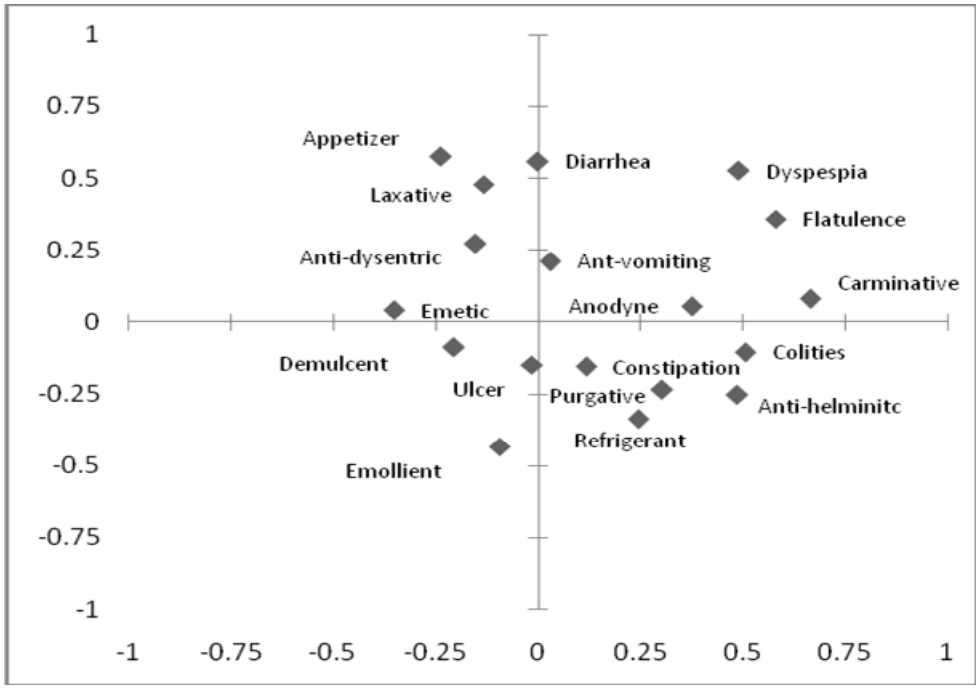
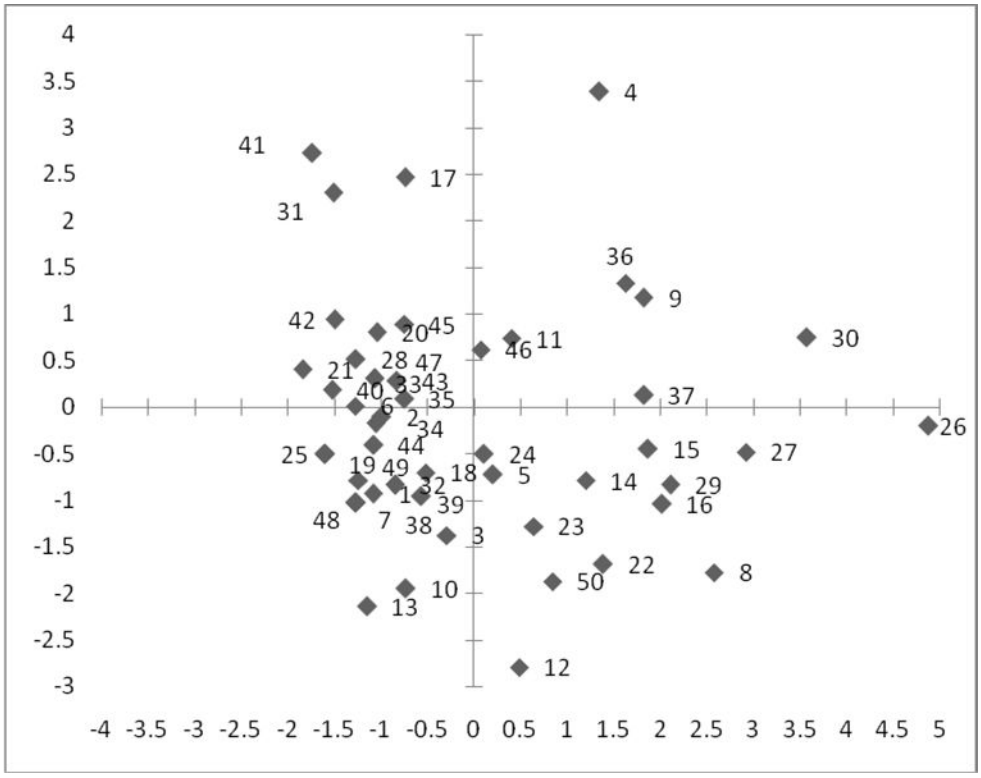


Figure 4: PCA bioplot of each species for Gastro-intestinal disorders



- = numerical numbers are correspondence to Table 5

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