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Physicochemical and Phytochemical Composition of Some Indigenous Sudanese Forest Fruits

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Abstract

In Africa indigenous fruit trees supplement the diet of many rural families by providing essential micronutrients and health benefits as well as serve as an alternative for cash and income resources. This study was carried out to determine physiochemical and phytochemical composition of six of the most common indigenous forest fruits in Sudan, Tabldi (*Adansonia digitata*), Aradaib (*Tamarindus indica*), Nabag (*Ziziphus-spina christi*), Doum (*Hyphaene thebaica*), Lalob (*Balanites aegyptiaca*) and Godeim (*Grewia tenax*). Physiochemical characteristics of Tabldi and Lalob showed high value of carbohydrates 78.24% and 75.60%, respectively, while, considerable values of fiber were found in Lalob (5.91%) and Nabag (4.23%). However, the moisture protein and fat levels were relatively low, lalob showed the highest moisture and fat content (6.88 and 0.43% respectively). 0.86% was the highest protein content which obtained by Aradaib.

Moreover Tabldi was the highest ash content (6.35%). The study was showed significant difference ($p<0.05$) among the fruits in pH values which were below than 6.04. Gas chromatography–mass spectrometry (GC-MS) analysis of fruit extracts revealed the presence of carbohydrate, alkaloids, hydrocarbons, terpenoids, tannins, steroids glycosides, fatty and organic acids. Lalob exhibited the highest total polyphenol and total flavonoids content which were89.38 and 62.04 Mg/g respectively, while Godeim scored the lowest values 36.19and to26.90Mg/g, respectively.

Introduction

Sudan is one of the important and largest countries in Africa, which is rich in Non-Wood Forest Products (NWFPs) (Adedayo *et al*., 2010), it refers to ‘‘goods of biological origin other than wood, derived from forests (FAO, 1999). NWFPs constitutes an important part of human diets in many sub-Saharan African countries, particularly in rural areas, during droughts and especially at times of wars, calamities and crises(FAO,2013).The common NWFPs in Sudan are Lalob (*Balanites aegyptiaca*), Aradaib (*Tamarindus indica*), Tabldi (*Adansonia digitata*), Godeim (*Grewia tenax*), Nabag (*Ziziphus-spina christi*) and Doum (*Hyphaene thebaica*). Theses fruits are known to provide dietary fiber and essential nutrients such as vitamins and energy. In addition, they thought to be a good source of phytochemical components which were known as secondary plant metabolites and have biological properties such as antioxidant activity, antimicrobial effect, modulation of detoxification enzymes, stimulation of the immune system, decrease of platelet aggregation and modulation of hormone metabolism and anticancer property. Aradaib an important multipurpose indigenous fruit tree in all Africa (Okello *et al*., 2017).The fruit is rich in organic acids, pectin, vitamins, minerals content, polyphenol and flavonoid content. (De Caluwe *et al*., 2009).Lalob known as Heglei(Koko *et al*., 2000). This plant is an indigenous species in Sudan, popular and of great concern, previous studies on the pulp and kernel showed the presence of sterols, terpene, saponins, tannins, alkaloids and resins (Abdel-Rahim *et al.,* 1986).Baobab(Tabldi)is a very old fruit producing tree, its fruit provides a variety of important nutrients, rich in pectin and vitamin C (Diarra.,2006). It also has numerous health benefits which can be related to the presence of bioactive compounds (terpenes, saponins, tannins and many more) that are isolated from its various parts like leaves and fruits (Singh *et al.*, 2013).Godeim, is a rich source of carbohydrates, proteins, vitamins, minerals, and constituents which are important contributors to improving the nutritional contents of rural and urban people in Sudan (Abdelmutti, 1991). Phytochemical screening revealed the presence of alkaloids, carbohydrates, glycosides, proteins and amino acids, saponins, steroids, acids, mucilage, fixed oils and fats (Sulieman and Eldoma, 1994).Doum is listed as one of the useful plants of the world. The pulp contains nutritional trace minerals, proteins and fatty acids, in particular the nutritionally essential linoleic acid (Fletcher, 1997). The identification of compounds showed that the fruit contains significant amounts of saponins, coumarins, hydroxycinnamates, essential oils and flavonoids. The fruit also lowers blood pressure in animal models (Sharaf *et al.*, 1972).Nabag has been used in folk medicine as a demulcent, depurative, anodyne, emollient, stomachic, for toothaches, astringent and as a mouth wash (Nasif, 2002), The main constituents of its fruit were betulic and ceanothic acid (Shahat *et al.*, 2001) and three cyclopeptide alkaloids as well as four saponin glycosides (Mehran *et al.*, 1996). However, few studies are reported on their secondary metabolite and phytochemical contents, that why this study was undertaken to study Physicochemical and Phytochemical composition of these fruits.

2- MATERIALS AND METHODS

2.1 Preparation of Forest Fruits (NWFPs)

Forest fruits Aradaib, Lalob, Tabldi, Godeim, Doum and Nabag (Figures 1, 2, 3, 4, 5 and 6) were cleaned, ground and sieved then kept in a clean and sterilized glass container until required.

Figure1: Aradaib Figure2: Lalob Figure3: Tabldi

Figure4: Godeim Figure5: Doum Figure6: Naba

2.2 Preparation of crude extract

The extraction was carried out according to the method described by Sukhdev *et al.*, (2008).

2.3 Chemical composition

Physicochemical analysis and Yield of fruits extract were achieved according to the method described by AOAC (2005)

2.4 Phytochemical analysis

2.4.1 Detecting of phytochemicals components

GC-MS analysis of fruit ethanolic extracts was carried out by following the method of Hema *et al.*, (2010).

2.4.2 Determination of phytochemicals components

2.4.2.1Total phenol

The total Phenolic content in fruits extracts were measured using Foiln Ciocalteu(FC) reagent based on procedure described by Singleton *et al* (1999).

2.4.2.2 Total flavonoids

Aluminum chloride colorimetric method was used for Flavonoids determination. As described by (Pourmorad *et al*., 2006).

2.5 Statistical analysis

The data collected from the different treatments were subjected to analysis of variance and whenever appropriate the mean separation procedure of Duncan was employed (Steel and Torrie, 1980). The SAS program (SAS, 2002), was used to perform the general of liner model (GLM) analysis.

3. RESULTS AND DISCUSSION

Physicochemical composition of the indigenous Sudanese forest fruits are given in Table 1. Significant ($P \leq 0.05$) differences were observed in moisture content of the fruits. The highest moisture content 6.88% was recorded for Lalob, while, the lowest 4.50% for Doum. The first value was slightly lower 7.26% than that stated by Koko *et al.,* (2017), while, the second value was slightly higher 4.00% than the findings of FAO, (2006) for African Doum. Similar moisture results were obtained by Kabeir *et al.,* (2015) who found Lalob exhibited the highest moisture content 12.06%, whereas, Doum showed the lowest 4.96%. This range of moisture is normal for traditional fruits which scripted by long shelf life. Lower moisture content 4.47%, of Doum was found by Abdel-Rahman *et al.,* (2014). It was clear that, carbohydrates were significantly ($P \leq 0.05$) affected by the fruit species. The maximum carbohydrate content 78.24% was recorded for Tabldi, while, the minimum 75.60% was recorded for Lalob. The current result was supported by Mahgoub (2017), who stated that, the highest carbohydrate imparted sweet taste for Tabldi powder. The value of carbohydrates obtained for Tabldi is superior than 70.03%, mentioned by Dabora (2016). Kabeir *et al.,* (2015) stated the range of carbohydrate to be from 63.85% for

Godeim to a maximum of 80.9% for Nabag. Koko *et al.*, (2017) recorded 71.20% carbohydrate for Lalob and Abdel-Rahman *et al.*, (2014) reported a higher value for Godeim 84.89%. The indigenous fruits showed low protein content of 0.64% as in Nabag to a high level of 0.86% as in Aradaib. Referring to the same Table we could recognize that, the protein content of Aradaib and Nabag was significantly ($P \leq 0.05$) different. While there was no significant ($P \geq 0.05$) difference in protein contents of other fruits including: Lalob, Tabldi, Godeim and Doum of 0.70%, 0.66%, 0.76% and 0.72%, respectively. The present result was far from that found by Kabeir *et al.*, (2015) who found that, Aradaib and Nabag had protein content of 3.20 and 4.05%, respectively. Dabora (2016) stated that Tabldi had a protein content of 0.46%. Differences in protein content indicate variations in metabolic activity during the fruit development.

Concerning the fat content, there were no significant ($P \geq 0.05$) differences between Aradaib, Tabldi, Godeim and Doum. The six studied fruits showed relatively low fat levels. Lalob gave the highest fat content 0.43%, and Nabag fruit gave the lowest value 0.09%. In contrast, Kabeir *et al.*, (2015) found that, Nabag had higher fat content when compared to Lalob 2.55%.

Referring to the result of ash content presented in Table1, there was significant ($P \leq 0.05$) difference among fruits. The highest ash content 6.35%, was recorded for Tabldi, while, the lowest for Nabag 4.93%. Higher ash content 7.17% of Tabldi was found by Abdel-Rahman *et al.*, (2014). Similar result was reported by Kabeir *et al.*, (2015) who recorded that, 7.72% for Tabldi, whereas, the lowest was recorded for Nabag 2.72% and stated that, ash content of fruit was significantly affected by fruit type. Wickens (1979) found lower ash value 5.97% for Tabldi.

Concerning the fiber content, there was significant ($P \leq 0.05$) difference among fruits. The maximum fiber content 5.91% was recorded for Lalob, while, 4.23% was recorded for Nabag, Aamer (2015) and Kabeir *et al.*,(2015) reported 14.88 and 4.85 for Lalob and Nabag respectively. Significant differences were noticed in pH-values among different indigenous forest fruits. The maximum value of 6.04 was recorded for Doum fruit, while, the lowest 3.93, was recorded for Aradaib. Higher pH-value of Doum (6.04), and lower pH-value of Aradaib (3.93) was found by Mohamed *et al.*,(2010). These differences in chemical composition could be attributed to cultivation stage, soil type, fruit species and post-harvest conditions as stated by Bates *et al.*, (2001).

Table 2, shows that, the yield percentage was significantly ($P \leq 0.05$) influenced by the fruit types. The highest yield percentage was recorded for Doum44.16%, while, the lowest was recorded for Godeim17.86%. Slightly higher Godeim extract yield (18.6%) was found by Aamer (2015), however, Nabag, Aradaib, Lalob and Tabaldi yield extracts percentages were 32.48%, 29.76%, 27.96% and 20.11%, respectively. Higher Lalob yield (45.6%) was obtained by Abdallah *et al.,* (2012). These differences could be due to some factors such as: plant species, plant parts, extract method and environmental conditions of harvest as stated by Adam *et al.,* (2019).

Phytochemical Detection of the indigenous fruit extracts examined is presented in Table 3. (Appedix1). Results revealed that, only Aradaib was able to show positive result for all the phytochemicals under investigation. Rao and Mathew (1999) mentioned that, Aradaib contains considerable amount of alkaloides and polyphynolic compounds. Regarding Tabldi, carbohydrate, alkaloides, hydrocarbones, fatty acids, trepinoides, organic acids tannins and steroids were present with the exception of glycosides. Dabora (2016) reported that, Tabldi extract contains terpenoids, flavonoids, sterols, vitamins, amino acids, carbohydrates and lipid. Carbohydrates, hydrocarbones, fatty acids, organic acids, steroids and glycosids were detected in Lalob extract. On the other hand, Lalob extract was found free of alkaloids, trepinoides and tannins. Similar result was reported by Koko *et al.,* (2017) who found Lalob extract free of alkaloids. Concerning Godeim, Table 3, revealed that, carbohydrates, alkaloids, hydrocarbon, fatty acids, trepinoides, organic acids tannin and glycoside were present in Godeim extract, whereas, the extract was steriods free. In contrast, Aboagarib *et al.,* (2015) detected steroids in Godeim extract. Sati *et al.,* (2018) stated that, Godeim extract contains considerable amount of carbohydrates, organic acids, fatty acids and tannins. Bashir *et al.,* (1987) reported that, *Grewia tenax* had considerable amount of alkaloids. Carbohydrate, alkaloides, hydrocarbones, fatty acids, trepinoides and organic acids were detected in Doum. It is worth mentioning that, Doum extract is free of tannins, steroids and Glycosides. Similar result was mentioned by Aamer (2015) who showed Doum extract containing carbohydrates, organic acids, fatty acids, trepinoides and alkaloids. Results also showed that, Nabag extract contains carbohydrate, alkaloides, hydrocarbone, fatty acids, trepinoides, organic acids and tannins but steroids and glycosides free. Similar results were reported by other investigators showed that Nabag extract contained many compounds such as: peptide, cyclopeptides, alkaloids, flavonoids, sterols, tannins, butulinic acid, trepinoides, saponinand glycosides (Ikram *et al.*, 1981; Shahat *et al.*, 2001; Tripathi *et al.*, 2001). The quantitative screening of the ethanol extract of the different fruits is presented in Table 4.Significant (P≤ 0.05) differences of polyphenol were detected among the different fruit extracts. The highest total polyphenol was recorded for Lalob extract 89.38 mg/g, followed by Aradaib, Doum, Tabaldi and Nabag, Godeim exhibited the lowest level 36.19 mg/g of polyphenols. Abdelaziz *et al.*, (2020) found that Lalob extract had polyphenols of 75.30mg/g. Zohrameena *et al.*, (2017) found that, *Tamarindus indica* contains 76.60mg/g polyphenol. Lower total polyphenol compounds of Tabaldi (35.18-40.58mg/g) was showed by Lamien-Meda *et al.*, (2008).Higher levels of polyphenol of Doum extract (49.6mg/g), was obtained by Aamer (2015). Yossef *et al.*, (2011) found that, Nabag (*Ziziphusspina-cristi*) extract had 7.55mg/g total polyphenol. Elhassan and Yagi (2010) reported that, Godeim extract had total polyphenol of 12.90mg/g.Table 3, also illustrated that the total flavonoids was significantly (P≤ 0.05) influenced by the fruit extract types. Total flavonoids of the forest fruits were in the range of 26.90-62.04mg/g for Godeim and Lalob respectively. Lower total flavonoids of Lalob (47.4mg/g), was recorded by Abdelaziz *et al.*, (2020). The flavonoids of Godeim values obtained was lower than those of Sharma *et al.*,(2016). Doum recorded total flavonoids of 45.95.Higher total flavonoids of Doum (69.8mg/g), was recorded by Aamer (2015).Tabaldi showed 34.430mg /g flavonoids content which was higher than 23.60mg/g found by Mahgoub (2017). The current result of total flavonoids was 44.28mg/g for Aradaib which was slightly higher 44.11mg/g than that found by Mbunde *et al*(2018).Mahgoub (2017) stated that, fruit type, extract system, geographical location, plant age, and climatic conditions have enormous effects on the amount and activity of antioxidants available in fruits.

Table 1 Physicochemical composition (%) of selected traditional Sudanese fruits

Type of fruit	Moisture %	Carbohydrate %	Protein %	Fat %	Ash %	Fiber %	pH-value
Aradaib	6.60[b] (±0.16)	76.05[d] (±0.16)	0.86[a] (±0.16)	0.23[bc] (±0.06)	5.86[c] (±0.03)	5.48[b] (±0.03)	3.93[f] (±0.13)
Lalob	6.88[a] (±0.10)	75.60[f] (±0.16)	0.70[b] (±0.16)	0.43[a] (±0.06)	5.91[b] (±0.02)	5.91[a] (±0.90)	4.02[e] (±0.78)
Tabldi	5.81[c] (±0.00)	78.24[a] (±0.16)	0.66[bc] (±0.16)	0.33[b] (±0.16)	6.35[a] (±0.00)	5.38[c] (±0.23)	4.23[d] (±0.03)

Godeim	5.63^{d} (±0.00)	76.64^{c} (±0.16)	0.76^{b} (±0.16)	0.33^{b} (±0.24)	5.80^{d} (±0.02)	5.36^{d} (±0.90)	5.95^{b} (±0.23)
Doum	4.50^{f} (±0.00)	78.00^{b} (±0.16)	0.72^{b} (±0.16)	0.13^{bcd} (±0.12)	5.00^{e} (±0.98)	4.26^{e} (±0.32)	6.04^{a} (±0.80)
Nabag	5.53^{e} (±0.02)	75.98^{e} (±0.16)	0.64^{d} (±0.16)	0.09^{def} (±0.10)	4.93^{f} (±0.88)	4.23^{f} (±0.87)	5.92^{c} (±0.64)
$Lsd_{0.05}$	0.3328	0.44	0.08	0.09	0.54	0.44	0.07
SE±	0.108	0.14	0.04	0.03	0.10	0.44	0.02

*Values are means ± SD. Mean value (s) having different superscript letters in the same column are significantly (P≤ 0.05) different.

Table 2: Yield of fruit extracts

Type of fruit	Yield %
Aradaib	29.76^{c} (±0.00)
Lalob	27.96^{d} (±0.02)
Tabldi	20.11^{C} (±0.00)
Godeim	17.86^{f} (±0.00)
Doum	44.16^{a} (±0.00)
Nabag	32.48^{b} (±0.00)
$Lsd_{0.05}$	0.00
SE±	0.00

*Values are means ± SD. Mean value (s) having different superscript letters in the same column are significantly (P≤ 0.05) different.

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Table 3: Phytochemical compounds of some Sudanese indigenous fruit extracts

Type of fruit	Carbohydrates	Alkaloies	Hydrocarbone	Fatty acids	Trepinoides	Organic acids#	Tannins	Steriodes	Glycoside
Aradaib	+	+	+	+	+	+	+	+	+
Tabldi	+	+	+	+	+	+	+	+	-
Lalob	+	-	+	+	-	+	-	+	+
Godeim	+	+	+	+	+	+	+	-	+
Doum	+	+	+	+	+	+	-	-	-
Nabag	+	+	+	+	+	+	+	-	-

(+) = Present; (-) = Absent

Table 4: Total polyphenols and total flavonoids (Mg/g) of fruit extracts

Parameter	Doum	Lalob	Godeim	Aradaib	Tabldi	Nabag
Total polyphenols (Mg/g)	48.60^{c} (±0.03)	89.38^{a} (±0.11)	36.19^{e} (±0.23)	84.10^{b} (±0.67)	45.99^{cd} (±0.78)	43.83^{d} (±0.34)
Total flavonoids (Mg/g)	45.95^{b} (±0.90)	62.04^{a} (±0.97)	26.90^{f} (±0.75)	44.28^{c} (±0.84)	34.43^{d} (±0.67)	33.57^{e} (±0.01)

*Values are means ± SD. Mean value (s) having different superscript letters in the same raw are significantly ($P \leq 0.05$) different.

CONCLUSION

Based on the results obtained in the present study, the following conclusions can be drawn:

1-The fruit extracts contains considerable amount of carbohydrates and fiber.

2-Detection and determination of phytochemical compounds approved that the investigated fruits are a reliable source of phytochemicals.

3-The high values of polyphenols and flavonoids showed by Lalob indicate that it can be used as natural antioxidant.

It is recommended to uses Sudanese indigoes fruit in food processing, more research needed

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Appendix 1 Tables of GC-MS Analysis for phytochemical components of the Ethanolic Fruit extracts

Table 1 phytochemical components of Lalob extract

ID#	Name	Ret.Time	Area	Area%
1.	2,5-Furandione, 3-methyl-	3.545	737089	0.44
2.	2-Furancarboxaldehyde, 5-methyl-	3.742	1315492	0.79
3.	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	3.874	515025	0.31
4.	2-Octene, (E)-	4.270	801848	0.48
5.	2,5-Furandione, dihydro-3-methyl-	4.561	1018727	0.61
6.	Benzeneacetaldehyde	4.747	149774	0.09
7.	Pentanoic acid, 4-oxo-	4.843	625310	0.38
8.	1H-Imidazole-4-carboxylic acid, methyl ester	5.395	557212	0.33
9.	Levoglucosenone	5.721	659315	0.40
10	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	6.259	7613564	4.58
11	2-Pentanol, propanoate	6.947	1056356	0.63
12	1,4:3,6-Dianhydro-.alpha.-d-glucopyranose	7.194	2303138	1.38
13	5-Hydroxymethylfurfural	7.550	69193135	41.59
14	.beta.-D-Glucopyranose, 1,6-anhydro-	11.378	19009018	11.42
15	1,6-Anhydro-.alpha.-d-galactofuranose	12.750	12169904	7.31
16	3-O-Methyl-d-glucose	14.495	46640146	28.03
17	n-Hexadecanoic acid	15.832	919464	0.55
18	cis-Vaccenic acid	17.512	411660	0.25
19	.gamma.-Sitosterol	27.295	716675	0.43

Table 2: phytochemical components of Aradaib extract

ID#	Name	Ret.Time	Area	Area%
1.	2(5H)-Furanone	3.251	685796	0.10
2.	Cyclohexanone	3.349	1326323	0.19
3.	1H-Imidazole	3.521	2196502	0.32

4.	2-Furancarboxaldehyde, 5-methyl-	3.724	5223430	0.75
5.	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	3.866	2642162	0.38
6.	2-Pentanone, 1-phenyl-	4.729	1334567	0.19
7.	Pentanoic acid, 4-oxo-	4.824	1789038	0.26
8.	2,5-Dimethyl-4-hydroxy-3(2H)-furanone	5.056	977187	0.14
9.	Orcinol	5.261	451332	0.06
10.	2-Hexanone, 3,4-dimethyl-	5.314	2635350	0.38
11.	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl	6.234	29934073	4.30
12.	2(1H)-Pyridinone, 5-methyl-	6.581	333236	0.05
13.	Benzoic acid	6.771	324127	0.05
14.	Acetic acid, octyl ester	6.880	768768	0.11
15.	(S)-4-Isopropyl-3-propionyl-2-oxazolidinone	6.946	289904	0.04
16.	5-Hydroxymethylfurfural	7.710	230967869	33.15
17.	Malic Acid	8.623	1232767	0.18
18.	Heptanoic acid, 2-ethyl-, methyl ester	8.753	2742867	0.39
19.	Maltol	9.125	845182	0.12
20.	Methyl 4-O-acetyl-2,3-di-O-methyl-6-deoxy-.alpha.-D-mannopyranoside	10.463	1190651	0.17
21.	2,5-Methylene-d,l-rhamnitol	11.125	6424102	0.92
22.	.beta.-D-Glucopyranose, 1,6-anhydro-	11.490	13719779	1.97
23.	1,6-Anhydro-.beta.-D-glucofuranose	12.938	21862534	3.14
24.	4-O-Methylmannose	15.295	339713789	48.74
25.	n-Hexadecanoic acid	15.836	6683088	0.96
26.	Hexadecanoic acid, ethyl ester	16.049	824603	0.12
27.	1H-Imidazo[1,2-b]pyrazole, 2,3-dihydro-	16.377	970530	0.14
28.	Bicyclo[9.3.1]pentadeca-3,7-dien-12-ol, 4,8,12,15,15-pentamethyl-, [1R-(1R*,3E,7E,11R*,12R*)]-	16.515	1188698	0.17
29.	Oleic Acid	17.508	2087441	0.30
30.	Octadecanoic acid	17.692	2334848	0.34
31.	(1S,2E,4S,5R,7E,11E)-Cembra-2,7,11-trien-4,5-diol	17.853	2477940	0.36
32.	Nerolidolisobutyrate	17.997	3088511	0.44
33.	Acetic acid, 1-methyl-3-(2,2,6-trimethyl-bicyclo[4.1.0]hept-1-yl)-propenyl ester	18.974	245186	0.04
34.	Ledol	19.129	152858	0.02
35.	Octadec-9-enoic acid	19.280	376091	0.05
36.	Eicosanoic acid	19.432	310724	0.04
37.	13-Docosenoic acid, methyl ester, (Z)-	20.478	78425	0.01
38.	cis-10-Nonadecenoic acid, methyl ester	20.536	173588	0.02
39.	l-(+)-Ascorbic acid 2,6-dihexadecanoate	21.026	476666	0.07
40.	Squalene	22.910	568010	0.08
41.	17-Androstanone, 3-(3,4-dimethylphenyl)-3-methyl-	24.558	905476	0.13
42.	.beta.-Amyrin	24.660	1233373	0.18
43.	.alpha.-Amyrin	25.031	2978794	0.43

Table 3: phytochemical components of Tabldi extract

ID#	Name	Ret.Time	Area	Area%
44	1H-Imidazole, 4,5-dihydro-2-methyl-	3.271	663148	0.37
45	Cyclohexanone	3.360	683192	0.39
46	1H-Imidazole	3.519	5991733	3.39
47	2-Furancarboxaldehyde, 5-methyl-	3.744	697432	0.39
48	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	3.871	1610360	0.91
49	2-Methyliminoperhydro-1,3-oxazine	4.196	52761	0.03
50	2-Cyclopenten-1-one, 3-ethyl-2-hydroxy-	4.261	193731	0.11
51	Pentanoic acid, 4-oxo-	4.825	1122763	0.63
52	2,5-Dimethyl-4-hydroxy-3(2H)-furanone	5.056	1099111	0.62
53	6,7-Dioxabicyclo[3.2.2]nonane	5.317	583258	0.33
54	Maltol	5.416	7715359	4.36
55	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	6.231	11527559	6.52
56	4H-Pyran-4-one, 3,5-dihydroxy-2-methyl-	6.943	817558	0.46
57	5-Hydroxymethylfurfural	7.561	114410868	64.65
58	Sucrose	10.972	7437183	4.20
59	.beta.-D-Glucopyranose, 1,6-anhydro-	11.316	7094841	4.01
60	1,6-Anhydro-.alpha.-d-galactofuranose	12.763	6723509	3.80
61	Hexadecanoic acid, methyl ester	15.389	143109	0.08
62	n-Hexadecanoic acid	15.837	1534069	0.87
63	Hexadecanoic acid, ethyl ester	16.050	1821793	1.03
64	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	17.038	111044	0.06
65	9-Octadecenoic acid (Z)-, methyl ester	17.085	233046	0.13
66	9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)-	17.104	279590	0.16
67	Methyl stearate	17.301	56030	0.03
68	Oleic Acid	17.518	399522	0.23
69	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	17.556	236190	0.13
70	Linoleic acid ethyl ester	17.642	415811	0.24
71	Ethyl Oleate	17.695	168905	0.10
72	Gamolenic Acid	17.714	1308746	0.74
73	Squalene	22.911	293690	0.17
74	Urs-12-ene	25.032	346034	0.20
75	.gamma.-Sitosterol	27.320	1160381	0.66

Table 4: phytochemical components of Godeim extract

ID#	Name	Ret.Time	Area	Area%
1.	N-t-Butyl-N'-2-[2-thiophosphatoethyl]aminoethylurea	3.199	2015027	0.28
2.	Cyclohexanone	3.329	19628602	2.75
3.	2,5-Furandione, 3-methyl-	3.468	4929707	0.69
4.	2-Furancarboxaldehyde, 5-methyl-	3.672	7653270	1.07
5.	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	3.817	5096194	0.72
6.	2H-Pyran-2,6(3H)-dione	4.142	7781592	1.09
7.	Benzyl methyl ketone	4.660	1193025	0.17
8.	Thymine	4.736	713513	0.10
9.	Methyl acetoxyacetate	4.773	1640238	0.23
10	1,4-Dioxin, 2,3-dihydro-5,6-dimethyl-	4.930	2775960	0.39
11	2,5-Dimethyl-4-hydroxy-3(2H)-furanone	5.106	7167308	1.01
12	Orcinol	5.163	1346102	0.19
13	6,7-Dioxabicyclo[3.2.2]nonane	5.257	7018499	0.98
14	Oxazole-5-carboxamide, 4-methyl-N-acetyl-	5.404	9731326	1.37
15	1,3-Cyclohexanedione, 2-methyl-	5.544	2696442	0.38
16	Piperidine, 2,2,6,6-tetramethyl-	5.971	603495	0.08
17	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	6.315	78335191	10.99
18	2(1H)-Pyridinone, 5-methyl-	6.500	169537	0.02
19	Metacetamol	6.588	297583	0.04
20	Benzoic acid	6.652	202223	0.03
21	4H-Pyran-4-one, 3,5-dihydroxy-2-methyl-	6.859	4491856	0.63
22	2-Furancarboxylic acid, 3-methyl-, methyl ester	6.909	285986	0.04
23	3H-Pyrazol-3-one, 2,4-dihydro-4,4,5-trimethyl-	7.232	30901287	4.34
24	(S)-5-Hydroxymethyl-2[5H]-furanone	7.387	1925306	0.27
25	5-Hydroxymethylfurfural	7.801	384231326	53.93
26	1,2,3-Propanetriol, 1-acetate	8.005	14259989	2.00
27	1-Carbmethoxy-3,3-dimethyldiaziridine	8.850	38666152	5.43
28	2H-Quinolizine-1-methanol, octahydro-, (1R-trans)-	9.880	5628698	0.79
29	3-Butyl-4-nitro-pent-4-enoic acid, methyl ester	10.841	6046876	0.85
30	n-Hexadecanoic acid	15.778	21269910	2.98
31	Hexadecanoic acid, ethyl ester	15.983	924352	0.13
32	9-Octadecenoic acid (Z)-, methyl ester	16.647	3137908	0.44
33	9,12-Octadecadienoic acid (Z,Z)-	17.408	9569109	1.34
34	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	17.488	17850838	2.50
35	Linoleic acid ethyl ester	17.574	719606	0.10
36	Octadecanoic acid	17.623	3390959	0.48

37	Squalene	22.839	435629	0.06
38	Vitamin E	25.140	2939218	0.41
39	Stigmasterol	26.470	3114815	0.44
40	.gamma.-Sitosterol	27.076	1842075	0.26

Table 5: phytochemical components of Doum extract

ID#	Name	Ret.Time	Area	Area%
1.	Acetamide, N-(2-hydroxyethyl)-	3.250	2375116	3.91
2.	(R)-(+)-3-Methylcyclopentanone	3.344	1327023	2.19
3.	2,5-Furandione, 3-methyl-	3.527	394061	0.65
4.	2-Furancarboxaldehyde, 5-methyl-	3.733	540640	0.89
5.	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	3.870	760869	1.25
6.	2-Hydroxy-gamma-butyrolactone	4.318	581105	0.96
7.	3-Buten-2-ol	4.600	502625	0.83
8.	4-Chloro-2-butanone	4.726	331859	0.55
9.	Pentanoic acid, 4-oxo-	4.819	233259	0.38
10	2,4-Hexanedione	4.909	932000	1.53
11	2,5-Dimethyl-4-hydroxy-3(2H)-furanone	5.053	1127389	1.86
12	2-Heptanone, 3-methyl-	5.309	239963	0.40
13	2-Hexanone, 3-methyl-4-methylene-	5.406	2306333	3.80
14	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	6.234	5938014	9.78
15	5-Hydroxymethylfurfural	7.543	23781197	39.15
16	Sucrose	10.923	7465849	12.29
17	3-O-Methyl-d-glucose	14.185	8061179	13.27
18	n-Hexadecanoic acid	15.831	2551978	4.20
19	Hexadecanoic acid, ethyl ester	16.046	381585	0.63
20	9,12-Octadecadienoic acid (Z,Z)-	17.639	709097	1.17
21	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	17.708	189683	0.31

Table 6: phytochemical components of Nabag extract

ID#	Name	Ret.Time	Area	Area%
1.	2-Cyclopenten-1-one, 2-hydroxy-	3.342	1677328	1.33
2.	2,5-Furandione, 3-methyl-	3.514	4078108	3.24
3.	2-Furancarboxaldehyde, 5-methyl-	3.729	1573005	1.25
4.	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	3.870	1968438	1.56
5.	Hexanoic acid	3.980	1043663	0.83
6.	2-Propanone, 1-hydroxy-	4.724	405960	0.32
7.	Pentanoic acid, 4-oxo-	4.822	892017	0.71

8.	1,4-Dioxin, 2,3-dihydro-5,6-dimethyl-	4.922	836283	0.66
9.	2,5-Dimethyl-4-hydroxy-3(2H)-furanone	5.070	2837811	2.25
10.	6,7-Dioxabicyclo[3.2.2]nonane	5.311	910229	0.72
11.	Acetic acid, 1-(2-methyltetrazol-5-yl)ethenyl ester	5.417	4196562	3.33
12.	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	6.250	18789440	14.93
13.	Octanoic acid	6.555	252254	0.20
14.	5-Hydroxymethylfurfural	7.579	61133938	48.60
15.	Methanamine, N-[3-methyl-2-butenylidene]	8.205	891667	0.71
16.	Sucrose	11.111	22499474	17.88
17.	n-Hexadecanoic acid	15.828	1360635	1.08
18.	cis-Vaccenic acid	17.508	503966	0.40