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Characterization of oils and chemical analyses of the seeds of wild plants

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Abstract. The Chemical compositions of the seeds of some wild plants have been investigated. The seeds of *Hematostaphis berteri, Balanites aegytiaca* and *Ximenia americana* contain high levels of oils with values in the range, 38.2–54.5% (w/w). The iodine values of the oils were determined and, for *Ximenia americana,* the value was high, i.e., 149.8 mg/100 g. The storage properties of the oil of *Hematostaphis berteri* were examined over a period of fifty six days by exposure to light at ambient temperature. The peroxide value of the oil over the period increased by 12-fold of its initial value of 27.5 mEq/kg, suggesting light susceptibility to photo-oxidative degradation. The proximate protein contents were low but the concentrations of mineral elements in the seeds examined were generally high, exceeding the values for the corresponding mesocarps by several orders of magnitude.

Abbreviations: IV – iodine values; PV – peroxide values; SV – saponification values

Introduction

Considerable interest has been generated by the recent studies on the chemical composition of the fruits [1] and seeds [2] of some wild plants. The results have shown that some wild plants are sources of high levels of ascorbic acid and edible oils. For the latter, the seeds contain mainly polysaturates, i.e., non-drying oils with iodine values which are significantly less than 100. Polyunsaturates are, however more desirable not only in dietary terms but also in general application for paint formulation. Thus, in view of the need to find alternate sources of raw materials in quality and in viable quantities for the process industries, the present work is a study of some seeds in the wild which are known to contain oils and are also wholly edible, viz: *Balanites aegytiaca, Hematostaphis berteri* and *Ximenia americana.* Other edible seeds were examined not for oil contents, but for general chemical composition. The results of these studies are discussed in this paper.

Materials and method

The oils were soxhlet extracted from the seeds with petroleum ether (40–60 °C) and analysed by standard methods [3, 4]. The effect of light on the oils of *Hematostaphis berteri* was studied at ambient temperature over a period of 56 days.

The concentrations of crude protein in the seeds were determined by the Kjeldahl digestion method using analytical grade reagents. Calcium and magnesium were determined complexiometrically while the concentration of phosphorous was measured colorimetrically by the vanadate method [5]. Trace elements were determined by Atomic Absorption Spectrotometry (Philips mode SP9).

Determination of dl-α-tocopherol (Vitamin E). The concentration of dl-α-tocopherol was determined spectrophotometrically [6] using uv-vis spectrophotometer (Griffin). Specifically, different volumes of a stock solution of dl-α-tocopherol acetate in glacial acetic acid were measured into 100 ml volumetric flasks and were made up to the mark with glacial acetic acid. 2 ml of 0.25% (w/v) phosphomolybdic acid was added to 8 ml of each of the solutions and were allowed to stand for 15 min at 25 °C. The absorbance for each solution was measured at 700 nm.

0.5 g of the oil was added to 50 ml glacial acetic acid in a 100 ml volumetric flask and made up to the mark with the acid. 8 ml of the resultant sample solution was similarly treated with phosphomolybdic acid and absorbance measured as per the standard solutions.

Results and discussion

The proximate chemical compositions of five seeds are presented in Table 1. The oil contents for *Ximenia americana* and *Hematostaphis berteri* were 49.9

Table 1. Proximate composition of seeds

Seed	Oil (%)	Crude protein (%)	Crude fibre (%)	Ash (%)	Moisture (%)	Carbohydrate (%)
Hematostaphis berteri (Blood Plum)	54.5	4.11	2.4	1.0	9.0	29.0
Ziziphus spinachristi (Christ thorn)	–	4.5	9.0	–	12.5	–
Deterium microcarpum (Tallow)	7.4[a]	3.2	9.2	3.0	4.0	73.2
Balanites aegytiaca (Betu)	38.2	–	–	–	–	–
Ximenia americana (wild olive)	49.9	–	–	–	–	–

[a] Taken from Eromosele [2].

and 54.5% (w/w), respectively. These values are much higher than those reported for the seeds earlier studied [2]. The oil yield for *Hematostaphis berteri* is significant and compares favourably with the value for rubber seeds [7] i.e. 51%.

Crude protein was low for the seeds i.e. not exceeding 4.5%. Hence, the nutritional values of the seeds appear to derive from the oil and carbohydrate contents.

The chemical characteristics of the oils are presented in Table 2. The saponification values (SV) of the oils are in the range 165.5–213 and are comparable with the values for common oils [3] i.e., palm oil (196–205), groundnut oil (188–196) and corn oil (187–196). The iodine values (IV) are high except for *Balanites aegytiaca* and *Lophira lanceolata* with values of 76.2 and 59.7, respectively. The IV for *Ximenia americana*, i.e., 149.8, suggests that it is a semi-drying oil and is comparable with the values for safflower and soyabean oils i.e. 145 and 132 [3] respectively. Thus, judging from the IV of the oil from *Ximenia americana* and its yield, the seed appears to be a viable source of oil for paint formulation. In addition, since the whole seed is edible, the oil may be a good source of polyunsaturates for human nutrition. For *Hematostaphis berteri*, the IV of the oil was 125.7, i.e. lower than the value for *Ximenia americana*. Yet, the oil may also be suitable for oil paint and as dietary supplement.

The peroxide values (PV) indicated in Table 2 were determined immediately after the extraction of the oils. The PV were in the range 22.5–29.4 mEq/kg (excluding the values for *Lophira lanceolata*) and are relatively low compared with the values for the other oils [2]. However, the PV suggest some levels of oxidative reactions in the oils.

Vegetable oils are known to contain tocopherols which act as natural antioxidants and provide stability to oils during processing and storage. In view of the latter, the concentrations of dl-α-tocopherol were determined in the oils of *Hematostaphis beteri* and *Lophira lanceolata* (prepared locally). The results are shown in Table 2, i.e. 138.0 and 380.0 mg/g for the former and latter oils, respectively. These values are very high when compared with the literature values for some oils, e.g. 126 mg/100 g for winged bean oil [8].

Table 2. Chemical characteristics of seed oils[a]

Seed	Saponification value (mg/KOH)	Iodine value (g/100 g)	Peroxide value (mEq/kg)	Acid value (mg KOH)	% FFA (as oleic acid)	dl--tocopherol mg/g
Balanites aegytiaca	165.5	76.2	22.5	0.11	0.05	–
Hamatostaphis berteri	213	125.7	27.5	0.17	0.08	138.0
Ximenia americana	182.3	149.8	29.4	0.14	0.07	–
Lophira lanceolata[b] (local preparation)	–	59.7	31.2	–	–	380.0

[a] Extractant: Petroleum ether (40–60°C)

[b] Stored for a year at ambient temperatures

The storage properties of the oil from *Hematostaphis berteri* were studied over a period of 56 days by exposure to light at ambient temperatures. The results are represented in Table 3. The IV of the oil remained virtually unchanged over the period. The PV, however, increased by 12-fold on its initial value of 27.5 mEq/kg over the same period. The apparent stability of the IV is consistent with the high level of dl-α-tocopherol in the oil. The increase in PV is, however, not consistent with the level of the vitamin and suggests that for effective control of the oxidative peroxide formation an external antioxident should be added to the oil. It is interesting to note that for *Lophira lanceolata* oil with a very high level of dl-α-tocopherol, the IV remained unchanged over a period of one year.

Elemental analyses were conducted on seeds and the results are collected in Table 4. Many of the seeds were earlier studied for ascorbic acid contents and in some cases for mineral elements in the mesocarps of the fruit [1]. Magnesium levels in the seeds were in the range 170–24, 120 mg/100 g. *Nauclea latifolia* and *Gmelina arborea* contained the lowest and highest values of the element respectively. For calcium, the concentration ranged between 120–320 mg/100 g. Interestingly, for *Deterium microcarpum*, *Ziziphus spinachristi*

Table 3. Effect of light on the iodine value and Peroxide Value of the seed oil of *Hematostaphis berteri*

Storage period (days)	Iodine vaue (g/100 g)	Peroxide value (mEq/kg)
0	125.73	27.5
7	125.71	72.9
11	125.71	130.0
56	125.65	340.0

Table 4. Concentration of mineral elements in seeds

Seed	mg/100 g sample						
	Mg	Ca	Fe	Pb	Cu	Mn	P
Balanites aegytiaca (Betu)	437	240	0.30	ND	–	90	630
Nauclea latifolia	170	120	0.10	ND	–	120	–
Deterium microcarpum (Seed) (Tallow)	10,990	320	0.30	ND	96.0	110	60
Deterium microcarpum (mesocarp) (Tallow)	1,940	240	0.20	ND	–	90	300
Ziziphus spinachristi (Christ thorn)	11,720	320	0.30	ND	–	110	770
Ximenia americana (wild olive)	3,160	320	0.20	ND	–	90	870
Gmelina arborea	24,120	240	0.20	ND	–	80	1310

ND: Not detected.

and *Ximenia americana*, the concentrations of magnesium and calcium were much higher in the seeds than in the mesocarps [1]. Similarly, phosphorous concentrations were considerably higher in the seeds than in the mesocarps, in some cases, by a factor of over forty. In *Deterium microcarpum* however, the concentration of phosphorous was higher in the mesocarp. Overall, phosphorous concentrations were in the range 60–1310 m/100 g. Other elements analysed i.e. iron, mangenese and copper were present in relatively low concentrations. The concentration of iron was low in the seed compared with Roselle seed (8.2 mg/100 g) [9], Jojoba seed (9.2 mg/100 g) [10] and defatted okara seed (9.80 ± 0.96 mg/100 g) [11]. Lead was not detected in any of the seeds.

Conclusion

The seeds of *Hematostaphis berteri*, *Balanites aeygtiaca* and *Ximenia americana* contain high levels of oils ranging between 38.2–54.5% (w/w). The iodine values of the oils, with the exception of *Balanites aegytiaca*, suggest that the oils are semi-drying and may contain significant levels of polyunsaturates. The oil of *Hematostaphis berteri* appears to be susceptible to hydroperoxide formation over a period of 56 days on exposure to light at ambient temperature.

The protein contents of the seeds are low but the latter and all other seeds examined contain high levels of magnesium and calcium which exceed, by several orders of magnitude, the values for the corresponding mesocarps.

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