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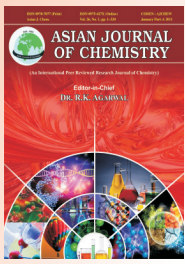

Physical Properties and Characteristics of *Salvia przewalskii* Seed and Seed Oil

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Physical properties and characteristics of *Salvia przewalskii* seed oil were investigated. The percentage composition of the *S. przewalskii* seeds is oil 28.38 % and crude protein content 29.44 %. The major nutrient element (mg/100 g) found in the seeds are potassium (915.7), magnesium (68.60), calcium (565.6). Physico-chemical properties of the oil include: ash-dry mater, 0.14 %; iodine value, 199.3 g/100 g of oil; the chlorophyll content 15.15 mg/100 g, *etc*. The oil shows absorbance in the UV ranges with potential use as a broad spectrum UV protectant. The oil contains high levels of α-linolenic acid (40.30 %), linoleic acid (28.65 %) and oleic acid (18.44 %), *etc*.

Keywords: *Salvia przewalskii*, Seed, Physicochemical property, Fatty acid, Development.

INTRODUCTION

Salvia, a genus of the Lamiaceae, is known as a prolific source of traditional Chinese medicine and national drugs[1]. *Salvia przewalskii* is one of functional food and medicinal material in China. The roots of *S. przewalskii* have been frequently used for the treatment of angina pectoris, myocardial infarction and atherosclerosis and liver diseases[2,3]. So, recent research is concentrated more on medicinal portions in *S. przewalskii*[4-6]. To our best of knowledge, *S. przewalskii* seed and seed oil is also a main by-product of *S. przewalskii* production, but those have not been studied before. In recent years, lots of *S. przewalskii* seed have high output in Qinghai and Gansu (in China), *S. przewalskii* seed and seed oil as food or cooking oil in some area. But for all that, a lot of seed were wasted or discarded in many places. Therefore, there is a lot of development perspective outside the sowing.

As important sources of oils with high nutritional, industrial and pharmaceutical importance, plant seeds have become the natural focus of attention of scientist by more and more attention[7]. At present, research on physicochemical properties of some *Salvia* species seed oil[8-10]. However, there is no information about *S. przewalskii* seed oil available in the literature. Thus, the aim of this study was to determine some characteristics and physical properties of *S. przewalskii* seed and seed oil, namely: fatty acid content, nutrition facts, moisture content, *etc*. to provide the basis for development and utilization of *S. przewalskii*.

EXPERIMENTAL

Seeds of *S. przewalskii* used in this study was a commercial seed from Longxi county (Gansu, China). The species were identified and authenticated by Prof. Y.H. Zhou of the Triticeae Research Institute, Sichuan Agricultural University and voucher specimens were prepared and deposited at the herbarium of the College of Biology and Science (SAU). The identification numbers of the voucher specimen *S. przewalskii* was WT20110803. The seeds were cleaned manually and the foreign matter, such as stones, dirt and broken seeds, were removed. Seeds were packed in hermetic plastic vessels and stored at -20 °C until analyses. Before starting a test, the seeds were taken out of the refrigerator and allowed to warm up at room temperature. Moisture content of samples was determined according to ISO665[11].

Chemical analysis of powdered seeds: The ash was determined according to the ISO2171[12]. The mineral constituents (K, Na, Ca, Mg, Zn, Fe, Cu, Mn) present in *S. przewalskii* seed were analyzed, using an atomic absorption spectrophotometer (AA-6300, SHIMADZU, Japan). The phosphorus content was determined by the molybdovanadate spectrometric method according to the ISO 6491[13]. Total protein was determined by the Kjeldahl method. Protein was calculated using the general factor (6.25)[7]. Data were expressed as per cent of dry weight.

Lipid extraction: Oil was extracted from seeds using hexane. The ground dried *S. przewalskii* seeds (40 g) were

placed into a cellulose paper cone and extracted with 400 mL hexane using a Soxhlet extraction apparatus for 4 h. The solvent was removed *via* a rotary vacuum distillation at 40 °C flushing with nitrogen to blanket the oil during storage. The weight of the oil extracted from 40 g of the seed powder was determined to calculate the lipid content. The result was expressed as the lipid percentage in the dry seed powder.

Chemical analysis of oil: The acid value of seed oil was determined according to the standard[14]. The iodine value was determined by known method[15]. The saponification value was determined according to the standard[16]. The peroxide value was determined as reported[17]. The unsaponifiable matter was determined according to the reported method[18]. The chlorophyll pigment was determined according to the standard and the carotenoid content was determined according to the standard, carotenoid content was expressed as micrograms of β-carotene per gram of oil[19,20].

Spectroscopy analysis: The spectroscopic indices UV-visible spectra were determined as outlined in the Standard Methods for the Analysis of Oils, Fats and Derivatives[21]. The *S. przewalskii* seed oil in hexane were measured with a spectrophotometer (UV-1750, SHIMADZU, Japan).

Fluorescence of *S. przewalskii* seed oil was measured with a fluorescence spectrophotometer (RF-5301PC, SHIMADZU, Japan). Excitation at 365 nm gave excellent results and was used as the excitation wavelength throughout the study. Emission fluorescence spectra were recorded from 390 to 770 nm. The oils were filtered (0.45 μm) and a 3 mL aliquot was used for analysis.

Fatty acid composition: The fatty acid composition of seed oil was determined according to the methods reported by Ixtaina *et al.*[22]. The relative percentage of separated compounds was calculated from total ion chromatography by the computerized integrator.

RESULTS AND DISCUSSION

The oil yield and the chemical properties of *S. przewalskii* seeds are presented in Table-1. It can be seen that seeds of *S. przewalskii* are composed of 28.38 % of oil, 4.42 % of ash and some nutrition elements (dry mater). Further more, the *S. przewalskii* seed contains significant amount of crude protein (29.44 %), potassium (915.7 mg/100 g), calcium (565.6 mg/100 g) and ferrum (18.26 mg/100 g). These seeds are rich in protein such as *Halimodendron halodendron* seeds[23]. Previous researches indicated that the oil content of *Salvia* species seed are between 2.4 and 27.1 %[9,10,24]. This shows that the oil content of *S. przewalskii* seed is higher than those of *Salvia*, but lower than *S. hispanica* (33.6 %, from Argentinean)[22]. This research suggests that the *S. przewalskii* seed is a potential developed seed depend on its high content of oil and crude protein in seed.

Physical properties of seed oil: According to this study, at room temperature *S. przewalskii* seed oil is liquid yellow-green in colour. Fig.1 compares the UV-visible spectra of the seed oils. Seed oil showed a strongly absorbance in the UV range. The optical transmission of *S. przewalskii* seed oil was comparable to that of *W. filifera* seed oil[7] in the UV range. Thus, *S. przewalskii* seed oil may be used in formulation of

TABLE-1
CHEMICAL PROPERTIES FROM SEEDS OF *S. przewalskii* (*IN mg/100 g OF DRY MATTER)

Component	Mean
Oil-dry mater (%)	28.38
Ash-dry mater (%)	4.42
Crude protein (%)	29.44
Phosphorus (P)*	40.68
Potassium (K)*	915.7
Sodium (Na)*	21.17
Calcium (Ca)*	565.6
Magnesium (Mg)*	68.60
Zinc (Zn)*	7.95
Ferrum (Fe)*	18.26
Copper (Cu)*	6.83
Manganese (Mn)*	1.78

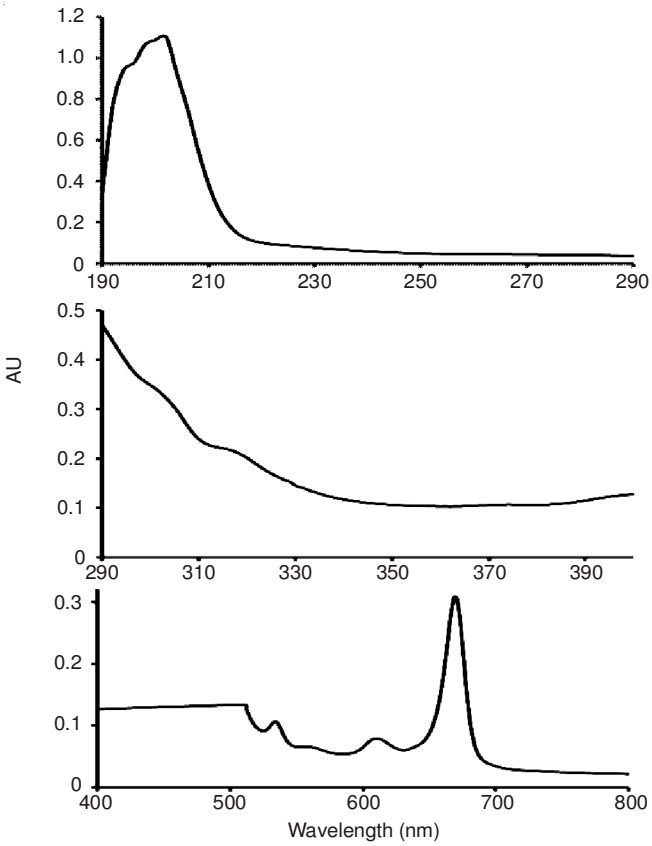

Fig. 1. UV/visible spectra of *S. przewalskii* seed oil (Figure derived from scans (k = 190-290 nm) of oil diluted 1:30000; from scans (k = 290-400 nm) of oil diluted 1:100 and from scans (k = 400-800 nm) of oil diluted 1:10, all in hexane

UV protectors that provide protection against both UV. Seed oil, the strong absorbance in the 630-730 nm range indicates the presence of an important quantity of chlorophyll which explains the intense close to green colour of the *S. przewalskii* seed oil and chlorophyll is used depend on the curative effect of chemoprevention to cancer, antigenotoxic[25,26]. Carotenoids, usually measured at 418-470 nm, was negligible as indicated by very low absorbance. A representative fluorescence spectrum of *S. przewalskii* seed oil (Fig. 2) reveals the presence of three major peaks: 524, 545 and 680 nm. The peaks at 680 nm also present in vegetable oils may be ascribed to the presence of chlorophyll in the oil, according to Kyriakid is and Skarkalis[27].

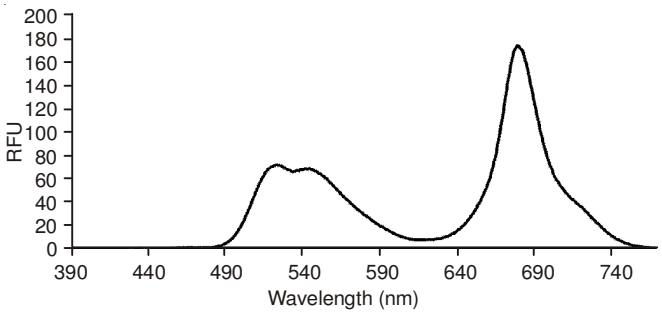

Fig. 2. Comparison of scanning fluorescence spectra of *S. przewalskii* seed oil, at 365 nm excitation

Chemical properties of seed oil: Table-2 shows the chemical and quality characteristicsof the *S. przewalskii* seed oil. The ash-dry mater was 0.14 %. The average acid value was 2.30 mg KOH/g oil. This value was higher than *S. hispanica* seed oil[22]. Therefore, *S. przewalskii* seed oil are not recommended for eaten straight, but when being used as the additives, the *S. przewalskii* seed oil can be added to cooking oil. The high iodine value (199.3 g/100 g) is due to its high content of unsaturated fatty acids (Table-3), this means *S. przewalskii* seed oil is drying oils. The high saponification value (219.1 mg KOH/g of oil) of *S. przewalskii* seed oil indicates a very high content of low molecular weight triacylglycerols. This result and *W. filifera* seed oil[7] are the same. The higher values of peroxide value found in *S. przewalskii* seed oil (22.59 meq/kg) indicating the presence of some quantity of unsaturated fatty acids in *S. przewalskii* seed oil. On the other hand, the seed oil is relatively unstable compared to other common plant oils, which can be ascribed to its high content of unsaturated fatty. The unsaponifiable matter of *S. przewalskii* seed oil (3.56 %) is higher than that of *S. hispanica* (0.68-1.27 %)[22].

TABLE-2
CHEMICAL COMPOSITION OF *S. przewalskii* SEED OIL

Component	Mean
Ash-dry mater (%)	0.14
Acid value (mg KOH/g)	2.45
Iodine value (g/100 g oil)	199.3
Saponification value	219.1
Peroxide value (meq/kg)	22.59
Unsaponifiable matter (%)	3.56
Chlorophyll (mg/kg)	15.15
β-Carotene (mg/kg)	0.29

This result indicating the presence of some quantity of tocopherols and sterol in *S. przewalskii* seed oil. It also demonstrates that fluorescence spectrum of *S. przewalskii* seed oil have obvious absorption. For this reason, *S. przewalskii* seed oil can be used as medicine intermediate, food additive and nutritional supplement to manufacture drugs and health products.

Fatty acid analysis: The fatty acid composition of *S. przewalskii* seed oil is presented in Table-3. The most important were palmitic acid, stearic acid, oleic acid, linoleic acid, α-linolenic acid, which together compose about 99.81 % of the total fatty acids. The saturated, monounsaturated and polyunsaturated fatty acid of *S. przewalskii* seed oil is 12.61, 18.44 and 68.96 %, respective.

The total unsaturated fatty acid of *S. przewalskii* seed oil is 87.39 %. Unsaturated fatty acids were regarded as a kind of fatty acid of dietary fatty acids, it has special physiological functions, such as cardio protective[29], can influence the physical proper-ties of the membrane such as fluidity and permeability[30]. *S. przewalskii* seed oil are rich in polyunsaturated fatty acid, Linoleic fatty acid is indispensable for the promote growth of human skin[31]. α-Linolenic acid showed the high bioactivity *in vivo* and also was the precursor of EPA and DHA, such as lowering the cholesterol and serum lipids, protecting from atherosclerosis and cardiovascular diseases, restraining allergen *etc*. *S. przewalskii* seed oil was characterised by a polyunsaturated/saturated ratio of 5.47, inferior to that of *S. hispanica* seed oil, superior to that of *S. miltiorrhiza* seed oil. The high values of these ratios are regarded favourable for the reduction of serum cholesterol and atherosclerosis and prevention of heart diseases[32].

Therefore, The fatty acid composition of *S. przewalskii* seed oil makes it desirable in terms of nutrition, *S. przewalskii* seed oil have great untapped potential. However, the safety of this oil must be tested before use for human nutrition.

Conclusion

This present study revealed that the *S. przewalskii* seed oil contains high relative percentage of polyunsaturated fatty acids. It is also more green-coloured than other vegetable oils and it can protect against UV light that causes cellular damage. Regarding these particular features, the value of this seed oil in cosmeticand food industries may be justified. However, the safety of this oil must be tested before its use for human nutrition.

TABLE-3
CONTENT OF FATTY ACID (%) IN *S. przewalskiI* SEED OIL

Fatty acid	This study	*S. miltiorrhiza* [Li *et al.*[24]]	*S. hispanica* [Peiretti *et al.*[28]]
Decanoic acid (10:0)	0.06		
Myristic acid (14:0)	0.13		
Palmitic acid (16:0)	9.10	9.79	7.1
Stearic acid (18:0)	3.32	2.72	3.3
Oleic acid (18:1)	18.44	22.30	6
Linoleic acid (18:2)	28.65	38.51	18.8
α-Linolenic (18:3)	40.30	26.68	64.1
Saturated	12.61	12.51	10.4
Monounsaturated	18.44	22.30	6
Polyunsaturated	68.95	65.19	82.9
Unsaturated/Saturated	6.93	6.99	8.55
Saturated/monounsaturated/polyunsaturated	1/1.46/5.47	1/1.78/5.21	1/0.6/8

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