Grasas y Aceites
Vol. 46 Fasc. 1 (1995), 26-28

Lipid composition of grains from wild grasses

By **J. A. Zygadlo*[a], A. L. Lamarque[a], D. M. Maestri[a] , C. A. Guzmán[a], N. R. Grosso[b]** and **E. I. Lucini[b]**

[a] Cátedra de Química Orgánica, Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba (IMBIV-CONICET). Avda. Velez Sarsfield 299, 5000 Córdoba. Argentina.

[b] Cátedra de Química Biológica, Facultad de Ciencias Agropecuarias (UNC). Córdoba. Argentina.

RESUMEN

Composición lipídica de los granos de pasturas silvestres.

Se estudió las características físico-químicas, la composición de ácidos grasos y esteroles de *Agropyron elongatum, Bromus catharticus, Festuca arundinacea, Stipa hyalina* y *Panicum maximum.* Los niveles más altos de proteínas fueron encontrados en *A. elongatum.* Dentro de los ácidos grasos el linoleico y el palmítico fueron los predominantes. En todas las muestras el β-sitosterol fue el esterol que se presentó en mayor cantidad, mientras que el Δ^7-estigmasterol fue detectado en cantidades trazas.

PALABRAS-CLAVE: Argentina — Composición lipídica — Estudio físico-químico — Pasto silvestre — Semilla.

SUMMARY

Lipid composition of grains from wild grasses.

Physicochemical characteristics, fatty acid and sterol composition were studied in grains of *Agropyron elongatum, Bromus catharticus, Festuca arundinacea, Stipa hyalina* and *Panicum maximun.* The highest protein level was found in *A. elongatum.* Linoleic and palmitic acids were the predominant fatty acids in all species. β-sitosterol was by far the most prominent sterol component in all samples, while Δ^7-stigmasterol was detected in only trace amounts.

KEY-WORDS: Argentine — Lipid composition — Physico-chemical study — Seed — Wild grass.

1. INTRODUCTION

Bovine meat and milk production is very important for the Argentine economy. Wild pastures are being used for bovine feed due to their. While all are considered to be good edible food little is known about their lipid composition.

The dietary lipid is subjected to biohydrogenation and others modifications by ruminant animals (Ekeren *et al.* 1992), a recent trend to improve the efficiency of animal production is to give ruminants feeds which contain fat supplements (Garton 1993).

The fatty acid composition of cow's milk depends on the nature of the feed (Garton 1993), grass seeds are one of the potential sources of significant amounts of dietary poly-unsaturated fatty acids (Price and Parsons 1974).

The broad objective of our programme is to derive new chemical information for characterizing the native and introduced grass genotypes, and to evaluate and compare nutritional factors in grains from different species.

This paper reports the results of the oil analysis of grains from four natural and one introduced grasses.

2. EXPERIMENTAL

Samples of *Agropyron elongatum* (Host.) Beauv., *Bromus catharticus* Vahl., *Festuca arundinacea* Schreb. and *Stipa hyalina* Nees and *Panicum maximun* Jacq. were obtained from the grasses germ plasm of Facultad de Ciencias Agropecuarias (Universidad Nacional de Córdoba).

The grains were milled and the oil was extracted with petroleum ether (30° - 60°C b.p.) in a Soxhlet apparatus. The extract was dried over anhydrous sodium sulphate and the solvent removed under reduced pressure in a rotary film evaporator (AOAC, 1980).

The fatty acid methyl esters were prepared by transesterification with absolute methanol containing 0.5N sodium methoxide (Knapp, 1979) and analyzed by gas liquid chromatography on a Shimadzu GC-1A chromatograph equipped with FID using an ATWAX, Superox II, capillary column (Alltech) (25mx0.25mm). The analysis was performed according to a specific program: from 180° to 240°C at a rate of 4°C/min. The temperature of the injector was 240°C. Nitrogen was used as carrier gas at a flow rate of 2 ml/min. The fatty acid methyl esters were also separated on a CBP10 column (Shimadzu) (30mx0.25mm). The temperature programme was 120° to 260°C, 2°C/min. Injector temperature was 250°C. The flow rate of nitrogen was 1ml/min.

Unsaponifiable material was fractionated on preparative TLC (20x20cm) coated with silica gel 60 G (1mm layer) (Itoh *et al.,* 1973). The sterols were separated on a capillary column OV-17 (2%) (25mx0.25mm), carrier gas nitrogen (1ml/min.), column temperature programme: 150° to 300°C, 10°C/min., FID was used.

Standards of fatty acid methyl esters and sterols were analysed in order to use retention times in identifying sample peaks.

The physicochemical characteristics and phosphorus content of oils were determined according to AOAC (1980) methods.

The nitrogen content was determined by the Kjeldahl method and converted to protein content by using the conversion factor 6.25 (Neucere and Sumrell, 1980).

Iodine values were determined by Hanus method (AOAC, 1980).

3. RESULTS AND DISCUSSION

The phosphorus, oil and protein contents are listed in Table I. The oil contents of all samples was lower than those obtained from other grasses (e.g. sorghum, oat and barley) (Neucere and Sumurell 1980; Padley *et al.* 1986). The phosphorus content of the oils varied from 179 ppm (*P. maximum)* to 201 ppm *(F. arundinacea)* and the protein content ranged between 89.7 and 128.8 g.kg-^{1} grains *A . elongatum (Ae)* (Table I) exhibited the highest level.

The physicochemical characteristics of oils are shown in Table I.

Table I
Physicochemical characteristics of *Agropyron elongatum* (Ae), *Bromus catharticus* (Bc), *Festuca arundinacea* (Fa), *Stipa hyalina* (Sh) and *Panicum maximun* (Pm) grain oils

	Species*				
Property	**Ae**	**Bc**	**Fa**	**Sh**	**Pm**
– Protein content (g.kg^{-1} grains)+	128.8±2.80	91.5±2.40	102.0±2.18	89.7±1.93	89.8±1.74
– Oil content (g.kg^{-1} grains)+	12.5±0.50	15.1±0.83	13.1±1.01	12.8±0.76	12.6±0.42
– Iodine value (Hanus)	107±1.53	74±1.47	94±1.07	88±1.35	124±2.08
– Unsaponifiable matter (g.kg^{-1} oil)	30.0±1.33	31.2±1.50	40.2±1.95	35.6±1.07	29.8±1.22
– Saponification value	181.0±3.32	182.3±2.75	180.0±2.48	187.2±3.15	180.0±2.42
– Refractive index (25°C)	1,470±0.003	1,480±0.005	1,480±0.004	1,475±0.003	1,475±0.002
– Relative density (25°C/water at 25°C)	0.921±0.001	0.926±0.002	0.930±0.002	0.924±0.001	0.925±0.001
– Phosphorus content (ppm)	184±3.45	193±3.00	201±2.76	185±2.80	179±3.52

* All values are means of three replicate analyses (n=3).
\+ On dry weight.

The fatty acid composition of total lipids shows that linoleic (32.2-59.6%) and palmitic (15.7-37.2%) acids predominate followed by oleic (12.3-20.2%) acid (Table II). These grasses showed many similarities to the fatty acid composition of other cereals (Neucere and Sumrell 1980; Barnes 1983; Osagie 1984; Padley 1986; Hemavathy and Prabhakar 1987). The concentration of palmitic acid was highest in *Sh* and *Bc* (>35.7%) and lowest in *Pm*, *Ae* and *Fa* (<23.0%). The linoleic content was lowest in *Bc* (32.2%) followed by *Sh* (37.7%) and maximun in *Pm* (59.6%). Lauric, myristic, palmitoleic, arachidic, behenic and lignoceric acids were also detected.

Table II
Fatty acid compositions (wt%), total of unsaturated fatty acids (Total u) and unsaturated and saturated fatty acid ratios (u/s) of grass wild species

	Species+				
Fatty acids	**Ae**	**Bc**	**Fa**	**Sh**	**Pm**
12:0	tr.*	tr.	3.2 ±0.15	tr.	tr.
14:0	tr.	tr.	4.6 ±0.22	tr.	tr.
16:0	23.0 ±0.43	35.7 ±0.89	23.0 ±0.62	37.2 ±1.32	15.7 ±0.52
16:1	2.1 ±0.21	1.6 ±0.09	1.7 ±0.10	1.7 ±0.15	0.6 ±0.10
18:0	5.6 ±0.20	7.0 ±0.23	5.5 ±0.18	3.0 ±0.32	3.1 ±0.10
18:1	12.3 ±0.36	20.2 ±0.48	12.5 ±0.20	13.1 ±0.10	16.1 ±0.21
18:2	54.4 ±1.35	32.2 ±0.90	44.5 ±1.25	37.7 ±1.10	59.6 ±2.45
18:3	1.0 ±0.10	1.1 ±0.20	2.9 ±0.18	5.0 ±0.51	3.0 ±0.15
20:0	0.6 ±0.10	0.9 ±0.06	0.9 ±0.10	0.8 ±0.06	tr.
22:0	tr.	0.6 ±0.10	tr.	1.0 ±0.15	0.6 ±0.06
24:0	tr.	tr.	0.8 ±0.15	tr.	0.6 ±0.06
total u	69.8 ±2.27	55.1 ±1.72	61.6 ±1.50	57.5 ±1.89	79.3 ±2.73
u/s	2.4 ±0.35	1.2 ±0.15	1.6 ±0.20	1.4 ±0.10	4.0 ±0.42

\+ Key to abbreviations of the species are in Table I. All values are means of three replicate analyses (n=3).
* tr <0.5%.

Table III
Sterol compositions (g.kg^{-1}oil) of grass wild species

Sterols	Species+				
	Ae	Bc	Fa	Sh	Pm
β-sitosterol	11.0 ±0.45	10.3 ±0.56	12.3 ±0.71	12.0 ±0.20	12.2 ±0.33
Stigmasterol	0.1 ±0.06	0.8 ±0.11	0.1 ±0.06	0.8 ±0.10	0.2 ±0.06
Campesterol	2.3 ±0.25	2.7 ±0.20	1.6 ±0.21	2.1 ±0.15	1.7 ±0.16
Cholesterol	tr.*	tr.	tr.	tr.	tr.
Δ^5–avenasterol	0.7 ±0.11	0.8 ±0.12	0.6 ±0.10	1.1 ±0.11	0.3 ±0.06
Δ^7–stigmasterol	0.1 ±0.10	0.1 ±0.06	0.2 ±0.10	0.1 ±0.06	0.2 ±0.10

+ Key to abbreviation of the species are in Table I. All values are means of three replicate analyses (n=3).
* tr. <50 mg.kg^{-1} oil.

Two distinct levels of unsaturated/saturated ratios are present in the fatty acids of these five grasses. Values of 2.4 and 4.0 are found for *Ae* and *Pm*, respectively, and the other three species fall in the range 1.2 to 1.4. It is conceivable that some of these differences are connected to genetic characteristics and may have value as chemical markers in breeding programmes (Neucere and Sumrell, 1980).

All the pasture grains examined contained β-sitosterol, campesterol, stigmasterol, Δ^5avenasterol, Δ^7stigmasterol and cholesterol (Table III). The β-sitosterol was dominant in all samples (10.3-12.3 g.kg^{-1} oil).

Δ^7 Stigmasterol, was present in small quantities, even in these oils which contained large amounts of linoleic acid, a characteristic which is often accompanied by high levels of this sterol, as is the case, for example in the safflower and sunflower oils (Conte *et al.* 1983; Conte *et al.* 1984).

ACKNOWLEDGEMENTS

Financial support for this project was provided by CONICET, CEPROCOR and CONICOR. The authors wish to acknowledge Ing. Agr. C.A. Vieyra for the provision of some material used in this study.

BIBLIOGRAPHY

Association of Official Analytical Chemists (1980).– *"Official Methods of Analysis".*– 13th edn. pp 437, 441, 442, 212, 276, 220. Washington: AOAC.

Barnes, P.J. (1983).– *"Lipids in Cereal Technology".*– London: Academic Press.

Conte, L.S., Frega, N., and Capella, P. (1983).– "Composition of the unsaponifiable oil fraction obtained from a number of cultivars of safflower".– J. Am. Oil Chem. Soc. **60**, 2003-2006.

Conte, L. S., Antonelli, A., Capella, P., and Guglicimi, A. (1984).– "Sunflower: relations among fatty acids, sterols and cultivations areas".– Riv. Ital. Sostanze Grasse **61**, 481-485.

Ekeren, P. A., Smith, D. R., Lunt, D. K., and Smith, S.B. (1992).– "Ruminal biohydrogenation of fatty acids from high-oleate sunflower seeds".– J. Anim. Sci. **70**, 2574-2577.

Garton, A. (1993).– "Sources of unsaturated fatty acids in the diet". In: *"Unsaturated fatty acids, nutritional and physiological significance".*– pp 6-11.– London, New York: Chapman and Hall.

Hemavathy, J. and Prabhakar, J.V. (1987).– "Lipid composition of rice (*Oryza sativa* L.) Bran".– J. Am. Oil Chem. Soc. **64**, 1016-1019.

Itoh, T., Tamura, T., and Matsumoto, T. (1983).– "Sterol composition of 19 vegetable oils".– J. Am. Oil. Chem. Soc. **50**, 122-125.

Knapp, R. D. (1979).– "Carboxilic acids". In *"Handbook of Analytical derivatization reactions".*– pp. 146-225.– Charleston: John Wiley and Sons.

Neucere, V. J. and Sumrell, G. (1980).– "Chemical composition of different varieties of grain *Sorghum".*– J. Agric. Food Chem. **28**, 19-21.

Osagie, A. U. and Kates, M. (1984).– "Lipid composition of millet *(Pennisetum americanum)* seeds.- Lipids **19**, 958-962.

Padley, F. B., Gunstone, F. D, and Harwood, J. L. (1986).– "Occurrence and characteristics of oils and fats". In: Gunstone, F. D., Harwood, J. L. and Padley, F. B. (eds.) *"The Lipid Handbook".*– pp 49-170.– London, New York: Chapman and Hall.

Proce, P.B. and Parsons, J.G. (1974).– "Lipids of six cultivated barley *(Hordeum vulgare* L.) varieties".– Lipids **9**, 560-565.

Recibido: Septiembre 1994
Aceptado: Enero 1995