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Near-infrared analysis (NIRT) of value enhanced maize inbreds kernels

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The physicochemical constitution of the maize kernel not only defines its nutritional value but also the ability to be used in transformation industries. Kernels quality depends on outward factors influenced by the environment, weather, soils, temperature, rainfall as well as the management technology used during crop growth and development aimed to obtain economically sustainable yieldings. Inherent factors of the kernel such as the genetic background undoubtedly influence its chemical quality and may be modified in profit of the chemical constitution and so achieve new germplasm with excellent attributes related to industrialization and nutritional value.

During the growing season 200//09, in the location of Virrey del Pino, province of Buenos Aires (34º49´57´´S, 58º43´23´´W; 20 masl) a complete randomized block design field trial with three replicates including fourty-four inbreds of which five were testers was sown. Plant density at harvest was 71,500 plants/ha. The materials generically termed CIG based on their endosperm attributes can be grouped as: **I.** *Modified starch, high amylopectin content maize (waxy)*, **II.** *High-quality protein maize (HQP)*, **III.** *High-quality protein and modified starch maizes (double mutants or DR)*, **IV.** *Soft and starchy endosperm (SE)*, **V.** *Hard and vitreous endosperm maize (VE).*Only kernels obtained by hand pollination (selfings or sib´s) were analyzed to prevent xenia particularly on oil content. The kernels, after harvest, were kept in a cold camera until analysis. The gross chemical was determined using an infrared spectrophotometer model Foss Infratec 1241 Grain Analyzer to quantify through a non-destructive assay proteint content (%), starch content (%) and oil content (%). Two 60 g samples of each genotype were analyzed and their results were averaged to obtain the final values. The simple correlation coefficient (*Pearson*) among the different chemical components was estimated.

The Table enclosed summarizes the information relative to the chemical composition of each inbred determined via NIRT. Whether in average, the oil content of maize kernels is relatively low and ranges from 3 to 5%, usually the varieties most commonly commerced around the world only have 3.0 to 3.5% oil. According to data published by ILSI and based on samples taken worlwide (Source= *ILSI Crop Composition Database version 2.0; www.cropcomposition.org*) maize oil content varies from 1.74 to 5.56% but if it is only considered the maize produced in Argentina the rank is about 2.68 to 5.56%.

Instead, MAIZAR (Argentine Maize Association) eventually reported that the oil content measured by NIRT technology on 48 commercial hybrids sampled within the limits of the ZMT and the southeastern area of the Province of Buenos Aires during the growing season 2004/05 ranged from 3.9 to 6.5%. Taking in count the information published by ILSI and MAIZAR but particularly the recommendation of the U.S. Grain Council (1999), all the inbreds with 6% or higher oil content, amongst those evaluated, were characterized as high oil maize (HOC). So, according to this criteria, the 29,5% (13/44) of the genotypes analyzed may be considered HOC. The oil content of the fourty-four inbreds varies from 4.4 to 8.2% whilst the environment media for the trait was 5.7%. The inbred CIG18 has the highest oil content (8.34%) followed by CIG52 (7.3%) and CIG30 (7.1%).

In general, maize protein content varies deeply according to genotype, production environment, sampling and calculation factors used to convert N into protein. Maize as the other cereal crops is relatively poor in kernel protein content as usually varies from 8.0 to 11.0% according to FAO reports. ILSI Argentina, estimated an average protein content of about 9.5% based on 109 commercial hybrids sampled in the provinces of Buenos Aires and Córdoba between 1999 and 2001. This value is coherent with others published in the Argenfoods database, (Universidad Nacional de Lujan, 2002). The inbreds included in the Table enclosed showed an average protein content ranging from 8.9 to 13.3%. The 61.4% of the inbreds surpassed the upper limit for protein content reported by FAO as they showed values ranging from 11% to 13.3%. The highest kernel protein content was shown by the waxy inbred CIG1 (13.3%) followed by the double mutant CIG38 (13.2%), the hard endosperm inbred CIG32 (13.1%) and the waxy inbred CIG8 (12.8%).

Kernels starch content ranged from 65.5 to 72.9% for the CIG inbreds, being the environment average for the trait 69.5%. The average starch content of these inbreds is coherent with the values published by INTA Pergamino (Technical report 320, 1999) that points out an average of 70.6% and values ranging from 67.8 to 73.4%. Similar values were also communicated by the National Food Office in 2007 as reported that argentine maize varieties have an average starch content of 71.3% (*range= 64.0 to 78.0%*) which is very close to the 72.0% reported by FAO in 1993. Other contrymen authors like Borrás *et al.* in 2002 (*Crop Sci. 42:781-790*) found a range between 65.0 to 70.0% for kernel starch content in commercial hybrids grown in Argentina. Our results indicate that the highest kernel starch content belongs to the waxy inbred CIG8 (72.9%) followed by the starchy inbred CIG42 (72.5%) and the double mutant CIG42 (72.2%).

Finally, Pearson´s correlation coefficients among oil, starch and protein content were calculated. The results suggest once more, as in previous MNL reports, that there is not a significant association between oil and protein content (*r= -0.03; ± Student´s t= 0.17*) although negative and highly significant associations (*p: 0.01*) were found between oil and starch content (*r= -0.64; ± Student´s t= 5.34*) similarly to reported by Wassom *et al.*, 2008 (*Crop Sci. 48:243-252*) and also between protein and starch content (*r= -0.43; ± Student´s t= 3.07*).

Those inbreds yielding more than 6.0% oil and considered as HOC genotypes could be used as male progenitors in future crossings. Similarly, inbreds with 12.0% or more protein content are suitable to be used as females in future breeding according to the protein inheritance model proposed by Corcuera and Naranjo in 1995 (*Proc. of the III Reunión Latinoamericana and XVI Reunión de la Zona Andina de Investigadores en Maíz*, Tomo II, pp.: 855-864, Cochabamba-S. Crúz de la Sierra, Bolivia).

The results obtained easily demonstrate that many of the CIG inbreds analyzed overcome the average protein, starch and oil content reported for these chemical constituents of the maize kernel by several authors or organizations on the basis of national or worldwide varieties.

		% OF		
INBRED	**TYPE**	**OIL**	**PROTEIN**	**STARCH**
CIG1	***Waxy***	***5,5***	***13,3***	***67,5***
CIG4	***Waxy***	***5,1***	***10,8***	***70,5***
CIG6	***Waxy***	***5,8***	***12,0***	***68,4***
CIG7	***Waxy***	***5,7***	***11,2***	***70,5***
CIG8	***Waxy***	***4,7***	***12,9***	***72,9***
CIG9	***Waxy***	***4,7***	***12,2***	***70,5***
CIG10	***Waxy***	***5,7***	***10,6***	***71,3***
CIG11	***Waxy***	***5,5***	***12,1***	***71,9***
CIG12	***Waxy***	***5,5***	***10,7***	***71,6***
CIG13	***Waxy***	***4,6***	***10,2***	***71,4***
CIG15	***Waxy***	***6,4***	***11,0***	***69,2***
CIG41	***Waxy***	***6,2***	***11,5***	***68,3***
CIG49	***Waxy***	***5,2***	***11,5***	***69,3***
CIG16	***HQP***	***5,8***	***11,3***	***69,9***
CIG17	***HQP***	***5,8***	***11,5***	***70,1***
CIG18	***HQP***	***8,2***	***10,6***	***67,3***
CIG20	***HQP***	***6,2***	***11,5***	***66,7***
CIG23	***HQP***	***6,1***	***10,6***	***69,0***
CIG34	***HQP***	***4,7***	***11,4***	***70,3***
CIG35	***HQP***	***5,1***	***11,8***	***69,6***
CIG45	***HQP***	***6,3***	***11,2***	***68,2***
CIG46	***HQP***	***5,2***	***11,6***	***69,3***
CIG56	***HQP***	***7,0***	***11,1***	***68,0***
CIG57	***HQP***	***5,3***	***12,4***	***67,7***
CIG27	***DR***	***5,7***	***11,3***	***69,8***
CIG29	***DR***	***5,2***	***12,0***	***68,9***
CIG30	***DR***	***7,1***	***10,4***	***68,5***
CIG36	***DR***	***4,7***	***12,1***	***69,3***
CIG38	***DR***	***5,7***	***13,2***	***67,7***
CIG39	***DR***	***6,0***	***11,2***	***68,6***
CIG40	***DR***	***6,1***	***9,5***	***69,9***
CIG42	***DR***	***4,4***	***8,9***	***72,2***
CIG43	***DR***	***5,9***	***10,1***	***68,9***
CIG44	***DR***	***6,2***	***10,6***	***69,5***
CIG47	***DR***	***5,4***	***10,6***	***69,9***
CIG50	***DR***	***5,6***	***10,2***	***71,7***
CIG52	***DR***	***7,3***	***12,1***	***65,5***
CIG55	***DR***	***6,0***	***9,6***	***69,7***
CIG48	***SE***	***5,8***	***11,7***	***67,8***
CIG51	***SE***	***5,0***	***9,7***	***72,5***
CIG53	***SE***	***4,6***	***10,1***	***71,9***
CIG54	***SE***	***4,7***	***10,4***	***70,6***
CIG32	***VE***	***5,8***	***13,1***	***67,9***
CIG37	***VE***	***5,5***	***12,5***	***68,4***
average		***5,7***	***11,2***	***69,5***
minimun value		***4,4***	***8,9***	***65,5***
maximun value		***8,2***	***13,3***	***72,9***