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Characterization of Spanish peanut germplasm (*Arachis hypogaea* L.) for sugar profiling and oil quality

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ABSTRACT

Peanut is an important oilseed crop of tropical and sub-tropical area of the world. As a rich source of energy, vitamins and minerals, it has been accepted for table purpose as snacks in domestic and international market. The quality of seeds of sixty Spanish germplasm accessions of peanut were analyzed for their glucose, sucrose, raffinose family oligosaccharides (RFOs) and fatty acid profile. Significant genotypic differences were observed for all the traits. Among the saccharides, sucrose accounted for the major fraction with a mean value of 4.6% in the range of 2.44–7.61%; the mean value of RFOs was 0.62% in the range of 0.17–1.56% while the mean value for glucose was 0.04% in the range of 0.01–0.11%. The mean oil content was 50.3% in range of 47.0–54.6%. The fatty acid composition consisted 12.4–24.5% palmitic acid, 2.1–5.3% stearic acid, 40.3–51.5% oleic acid and 18.7–40.6% linoleic acid. Glucose content was found to be positively correlated with sucrose and negatively correlated with RFOs. The correlation between oil content and any of glucose, sucrose, or RFOs was not significant. Among the major fatty acids, a negative correlation between oleic acid linoleic acid was observed. Some genotypes were found to be superior individually for different traits and few were superior for multiple traits. NRCG 14436 was identified for high sucrose, low glucose and low oil content; NRCG 14470 was identified for low RFOs, low glucose and high oil content, and high O/L ratio; while NRCG 14404 was identified for low RFOs, low glucose and low oil content. High O/L ratio (>2.0) was observed in accessions NRCG 14472 with high oil content. Thus, superior accessions identified for different traits would be useful for peanut breeders looking for germplasm containing high oil, low oil, low RFO, high sucrose, low glucose and high O/L ratio.

1. Introduction

Peanut (*Arachis hypogaea*), also known as groundnut, is the second most important cultivated grain legume and the fourth largest edible oilseed crop in the world (Shilman et al., 2011). With an annual production of about 8 million tonnes, India ranks second in the world after China in production and second in export with 0.46 million tonne in the year 2011–12 (APEDA report, 2011–12). In India, until a few years ago, peanut used to be regarded merely as an oilseed crop, but over the years consumption pattern has changed due to urbanization on the one hand and availability of cheaper sources of oil on the other. Thus besides continuing to be an oilseed crop, peanut has now established itself as an important supplementary food crop too. Several long-term health benefits can be derived by direct consumption of peanuts owing to the presence of several functional components like tocopherol, niacin and folic acid; mineral components like Cu, Mn, K, Ca, and P; dietary fibres, phytosterols like resveratrol, beta-sitosterol; flavonoids and phenolic acids (Francisco and Resurreccion, 2008). Oleic acid, a monounsaturated fatty acid, and linoleic acid, a polyunsaturated acid, constitute approximately 80% of the total fatty acid composition of peanut (Treadwell et al., 1983). The confectionery type peanut has assumed great significance as snacks in domestic and international markets. Thus of late, in breeding programmes, a greater emphasis is being assigned for improving the sensory and nutritive quality of peanut as a foodstuff. Although for direct consumption the physical (shape, size and colour) attributes are considered very important, yet the chemical attributes are also being now assigned weightage to determine the sensory and nutritive qualities of peanuts. The quality requirements of confectionery peanut are distinctly different from that of a source of oil. Among the important confectionery traits are large seed size, high sucrose and protein contents and low glucose, RFOs and oil contents from sensory, culinary and nutritional points of view while a high oleic acid/linoleic acid (O/L) ratio value oil is desirable for enhanced shelf-life. Presence of large amount of free sucrose mainly contributes the sweetness (Mason et al., 1969). Furthermore, sucrose, upon hydrolysis, produces fructose and glucose,

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Table 1
List of Spanish germplasm along with origin used in the analysis.

SN	NRCG code	ICG code	Origin	SN	NRCG No.	ICG code	Origin
1	14324	36	IND	31	14411	6703	PRY
2	14326	81	UN	32	14414	6888	BRA
3	14329	118	IND	33	14420	7190	BRA
4	14334	334	CHN	34	14422	7906	ZIM
5	14335	397	USA	35	14423	7963	USA
6	14336	434	USA	36	14424	7969	ZIM
7	14343	1137	IND	37	14425	8083	SUN
8	14348	1711	BOL	38	14430	8567	URY
9	14349	1973	IND	39	14433	9157	PRI
10	14350	2019	IND	40	14434	9249	MUS
11	14351	2106	IND	41	14436	9418	MTQ
12	14361	3102	IND	42	14437	9507	PHL
13	14362	3240	UGA	43	14440	9809	MOZ
14	14363	3343	IND	44	14447	10384	NGA
15	14364	3421	IND	45	14456	11249	TZA
16	14365	3584	IND	46	14460	11515	CHN
17	14368	3746	ARG	47	14461	11651	CHN
18	14377	4543	UN	48	14462	11687	IND
19	14380	4684	USA	49	14465	12189	ISR
20	14381	4729	CHN	50	14470	12682	IND
21	14383	4750	PRY	51	14471	12697	IND
22	14384	4911	MWI	52	14472	12879	BUR
23	14385	4955	IND	53	14473	12921	ZIM
24	14387	5195	SDN	54	14474	12988	IND
25	14389	5236	CHL	55	14476	13491	CAR
26	14393	5494	MYS	56	14477	13603	IDN
27	14398	5779	IND	57	14482	13982	USA
28	14404	6263	BF	58	14485	14118	GBR
29	14405	6375	UN	59	14486	14127	GBR
30	14407	6407	ZIM	60	14493	14985	UN

ARG, Argentina; BF, Burkina Faso; BOL, Bolivia; Bot.GP., Botanical group; BRA, Brazil; BUR, Myanmar; CAR, Central African Republic; CHL, Chile; CHN, China; GBR, Italy; IND, India; ISR, Israel; NGA, Nigeria; MOZ, Mozambique; MTQ, Martinique; MUS, Mauritius; MWI, Malawi; Ori, Origin; PRI, Puerto Rico; PHL, Philippines; PRY, Paraguay; SDN, Sudan; SUN, Russia & CISs; TZA, Tanzania; UGA, Uganda; UN, unknown; URY, Urugay; USA, United States of America; ZIM, Zimbabwe.

which upon heating can react with some specific amino acids to form flavour components. The flavour of the roasted peanut plays an important role in its acceptance by consumers and other users (Grimm et al., 1996). Thus fatty acid composition and sucrose are considered as the major determinant of peanut quality (Nigam et al., 1989; Ajay et al., 2012).

The RFOs are considered noxious components as they cause flatulence (Bryant et al., 2004) and glucose (along with free amino acids) causes discolouration upon roasting (Newell et al., 1967). Although, as an oilseed crop RFO are of no consequence but as an item of food it acquires importance. Since peanuts are continually utilized for preparation of new and improved products, a thorough knowledge of the composition and characteristics of the constituents of the peanut kernel is basic to improving the quality of peanut products for edible uses. Thus, the present study was carried out to investigate the oligosaccharide profiling, oil content along with O/L ratio in peanut germplasm.

2. Materials and methods

Sixty Spanish peanut genotypes (Table 1) were raised at the farm of Directorate of Groundnut Research, Junagadh, Gujarat, India during *Kharif*-2011. Recommended agronomic practices were followed to raise a good crop. Although the crop was raised in rain-fed condition, supplementary irrigation was provided as and when required to avoid any water deficit stress. Sampling was made by selecting sound and mature kernels from the produce. During biochemical analysis, each sample was divided into three equal parts and analyzed separately as subsamples. For statistical analysis, each subsample was considered as replication to calculate standard deviation for each genotype.

2.1. Determination of oil content and O/L ratio

The samples were ground to fine meal and oil content was determined by Soxhlet method as outlined by Misra et al. (2000). The fatty acid composition of oil was determined on a gas chromatograph by following the protocols described by Misra and Mathur (1998).

2.2. Determination of glucose, sucrose and RFOs contents

The saccharides from the defatted meal were extracted and quantified by the method described by Tahir et al. (2011) using a commercially available kit (Megazyme International Ireland Ltd., Bray, Ireland cat. no. K-RAFGL 05/2008).

2.3. Statistical analysis

Analysis of variance (ANOVA) was performed using DSAASTAT 1.1 (Onofri, 2007) and correlation between different traits was studied using PAST v1.89 software (Hammer et al., 2001). Desirable genotypes containing higher amount of sucrose and oil content, and high O/L ratio were identified using formula 1, whereas genotypes containing low RFOs, glucose and oil content were identified using formula 2.

Formula 1. $X_i > X_p + sd_1 + sd_2$
Formula 2. $X_i < X_p - sd_1 - sd_2$

where
X_i, mean of individual genotype; X_p, population mean; sd_1, standard deviation of individual genotype; sd_2, standard deviation of population.

3. Results and discussion

Peanut seeds of sixty Spanish germplasm accessions were studied for quality traits like sugars, oil and O/L ratio. Significant genotypic variations were observed among all the traits studied.

3.1. Variation in sugars

Among the saccharides, sucrose accounted for the major fraction with a mean value of 4.6% in the range of 2.44–7.61%; the mean value of RFOs was 0.61% in the range of 0.17–1.56% while the mean value for glucose was 0.04% in the range of 0.01–0.11%. The maximum glucose content was observed in NRCG 14404 whereas it was minimum in NRCG 14436 (Table 2). As sucrose is the most abundant saccharide in peanut and it was maximum in NRCG 14350 which was significantly different from other genotypes whereas NRCG 14465 had minimum concentration. There was a 3-fold difference in sucrose content between the genotypes containing maximum and minimum sucrose. The range of sucrose content in present study was similar to previous reports in peanut (Newell et al., 1967; Mason et al., 1969). The sweet attribute in peanut is a heritable trait (Pattee et al., 2000) and selection could be made for improving these traits. Although sucrose is a constituent of RFOs, the correlation between the sucrose and RFOs content was non-significant indicating that the synthesis of RFOs in peanuts depends more on the enzymatic addition of galactose on sucrose moiety rather than availability of sucrose. Significant difference was also observed for raffinose content which ranged from 0.17 (NRCG 14404) to 1.56% (NRCG 14434). Raffinose, stachyose and verbascose are major galactosyl-sucrose oligosaccharides (GSO) or raffinose family oligosaccharides (RFOs) in many food legumes (Shallenberger et al., 1967) and considered as anti-nutritional factor (Rackis, 1975). The lack of α-galactosidase enzyme in humans

Table 2
Glucose, sucrose, RFOs, oil content and O/L with range and mean in 60 peanut germplasm.

Genotype (NRCG code)	Glucose (g 100 g^{-1}) Mean ± sd	Sucrose (g 100 g^{-1}) Mean ± sd	RFOs (g 100 g^{-1}) Mean ± sd	Oil (g 100 g^{-1}) Mean ± sd	O/L Mean ± sd
14465	0.047 ± 0.001	2.440 ± 0.122	0.468 ± 0.018	49.2 ± 0.8	1.11 ± 0.03
14470	0.011 ± 0.002	3.570 ± 0.269	0.254 ± 0.032	51.8 ± 0.6	1.83 ± 0.06
14471	0.024 ± 0.002	3.311 ± 0.062	0.329 ± 0.022	50.9 ± 0.3	2.26 ± 0.10
14472	0.023 ± 0.002	3.403 ± 0.069	0.436 ± 0.016	51.7 ± 0.8	2.63 ± 0.14
14473	0.029 ± 0.002	3.729 ± 0.065	1.435 ± 0.342	48.2 ± 0.6	2.34 ± 0.01
14474	0.011 ± 0.002	3.894 ± 0.031	0.355 ± 0.060	48.8 ± 0.6	1.20 ± 0.01
14476	0.009 ± 0.001	3.497 ± 0.303	1.328 ± 0.108	48.4 ± 0.8	1.26 ± 0.03
14477	0.023 ± 0.001	4.235 ± 0.106	0.782 ± 0.023	49.2 ± 0.7	1.19 ± 0.04
14482	0.082 ± 0.008	4.433 ± 0.195	0.694 ± 0.054	50.8 ± 1.1	1.08 ± 0.02
14485	0.042 ± 0.004	4.011 ± 0.048	0.277 ± 0.032	49.0 ± 0.3	1.39 ± 0.03
14486	0.029 ± 0.004	3.284 ± 0.041	0.820 ± 0.056	48.8 ± 0.7	1.15 ± 0.03
14493	0.071 ± 0.003	4.528 ± 0.168	0.229 ± 0.005	50.6 ± 1.0	1.35 ± 0.02
14324	0.043 ± 0.004	4.679 ± 0.152	0.384 ± 0.016	53.0 ± 0.7	1.30 ± 0.03
14326	0.039 ± 0.003	4.811 ± 0.031	0.397 ± 0.013	51.8 ± 0.7	1.36 ± 0.05
14329	0.027 ± 0.002	3.625 ± 0.030	0.713 ± 0.018	54.6 ± 1.2	1.71 ± 0.04
14334	0.034 ± 0.002	3.519 ± 0.019	0.583 ± 0.062	51.1 ± 0.8	1.01 ± 0.01
14335	0.066 ± 0.002	5.357 ± 0.134	0.761 ± 0.053	51.9 ± 0.8	1.25 ± 0.01
14336	0.053 ± 0.002	4.456 ± 0.285	0.539 ± 0.064	53.4 ± 0.7	1.10 ± 0.02
14343	0.063 ± 0.003	5.507 ± 0.260	0.291 ± 0.038	51.5 ± 0.3	1.31 ± 0.04
14348	0.061 ± 0.003	5.010 ± 0.113	0.479 ± 0.030	49.7 ± 0.6	1.16 ± 0.03
14349	0.056 ± 0.001	5.808 ± 0.107	1.334 ± 0.169	51.8 ± 0.5	1.27 ± 0.04
14350	0.064 ± 0.002	7.605 ± 0.300	0.591 ± 0.050	49.3 ± 1.0	1.24 ± 0.03
14351	0.061 ± 0.004	6.104 ± 0.127	0.664 ± 0.048	54.0 ± 1.5	1.25 ± 0.05
14361	0.049 ± 0.005	5.647 ± 0.137	0.450 ± 0.033	49.2 ± 0.8	1.05 ± 0.03
14362	0.043 ± 0.004	4.505 ± 0.312	0.221 ± 0.067	49.5 ± 0.8	1.17 ± 0.03
14363	0.036 ± 0.002	4.842 ± 0.115	0.329 ± 0.006	50.6 ± 0.8	1.16 ± 0.02
14364	0.031 ± 0.012	4.615 ± 0.266	0.522 ± 0.029	50.8 ± 0.6	1.27 ± 0.05
14365	0.036 ± 0.002	4.801 ± 0.064	0.566 ± 0.042	51.8 ± 0.7	1.23 ± 0.01
14368	0.023 ± 0.001	5.281 ± 0.060	0.371 ± 0.042	48.2 ± 1.8	1.16 ± 0.03
14377	0.023 ± 0.001	4.662 ± 0.110	0.259 ± 0.023	51.0 ± 0.7	1.22 ± 0.02
14380	0.029 ± 0.001	5.704 ± 0.072	0.870 ± 0.028	48.9 ± 0.6	1.24 ± 0.04
14381	0.019 ± 0.002	5.662 ± 0.257	0.508 ± 0.041	47.4 ± 1.3	1.26 ± 0.04
14383	0.037 ± 0.001	4.399 ± 0.247	0.741 ± 0.039	51.2 ± 1.0	1.24 ± 0.03
14384	0.029 ± 0.001	5.179 ± 0.145	0.773 ± 0.020	51.1 ± 1.1	1.17 ± 0.02
14385	0.047 ± 0.035	5.433 ± 0.207	0.647 ± 0.083	49.7 ± 1.3	1.10 ± 0.02
14387	0.063 ± 0.001	5.801 ± 0.220	0.488 ± 0.048	51.5 ± 0.8	1.22 ± 0.03
14389	0.063 ± 0.001	4.634 ± 0.291	0.852 ± 0.052	50.2 ± 0.5	1.17 ± 0.04
14393	0.064 ± 0.002	5.471 ± 0.277	0.902 ± 0.050	52.0 ± 0.6	1.17 ± 0.01
14398	0.075 ± 0.003	5.431 ± 0.317	0.752 ± 0.022	49.4 ± 0.8	1.27 ± 0.02
14404	0.110 ± 0.005	4.696 ± 0.103	0.172 ± 0.041	48.0 ± 1.1	1.16 ± 0.02
14405	0.055 ± 0.002	3.716 ± 0.295	0.534 ± 0.039	50.7 ± 1.0	1.55 ± 0.07
14407	0.075 ± 0.003	4.328 ± 0.150	0.504 ± 0.017	49.3 ± 0.9	1.41 ± 0.02
14411	0.064 ± 0.003	4.882 ± 0.179	0.568 ± 0.039	48.4 ± 0.8	1.37 ± 0.03
14414	0.082 ± 0.004	5.292 ± 0.141	0.604 ± 0.027	49.0 ± 0.8	1.22 ± 0.02
14420	0.074 ± 0.002	6.002 ± 0.089	0.345 ± 0.015	48.5 ± 2.1	1.21 ± 0.03
14422	0.023 ± 0.001	4.191 ± 0.116	1.204 ± 0.034	49.9 ± 1.6	1.22 ± 0.05
14423	0.015 ± 0.001	4.378 ± 0.270	0.880 ± 0.052	50.3 ± 0.9	1.07 ± 0.02
14424	0.011 ± 0.001	4.285 ± 0.226	1.000 ± 0.021	49.0 ± 1.4	1.25 ± 0.04
14425	0.014 ± 0.002	4.214 ± 0.123	0.694 ± 0.061	49.3 ± 1.0	1.20 ± 0.01
14430	0.017 ± 0.001	4.035 ± 0.092	1.109 ± 0.112	51.0 ± 0.7	1.32 ± 0.03
14433	0.014 ± 0.001	4.538 ± 0.318	1.133 ± 0.037	49.7 ± 0.6	1.06 ± 0.01
14434	0.010 ± 0.000	4.259 ± 0.057	1.562 ± 0.078	49.7 ± 0.5	1.24 ± 0.04
14436	0.007 ± 0.001	5.745 ± 0.133	0.471 ± 0.051	48.6 ± 1.7	1.20 ± 0.04
14437	0.024 ± 0.018	4.794 ± 0.031	0.786 ± 0.073	49.2 ± 1.5	1.17 ± 0.02
14440	0.022 ± 0.001	3.569 ± 0.237	0.351 ± 0.053	52.2 ± 0.5	1.33 ± 0.01
14447	0.029 ± 0.001	4.551 ± 0.108	0.223 ± 0.013	53.2 ± 0.7	1.11 ± 0.07
14456	0.010 ± 0.001	4.521 ± 0.272	0.276 ± 0.036	48.5 ± 0.9	1.31 ± 0.07
14460	0.048 ± 0.003	3.632 ± 0.268	0.473 ± 0.032	53.3 ± 0.9	1.20 ± 0.03
14461	0.040 ± 0.006	5.333 ± 0.165	0.285 ± 0.008	48.2 ± 0.9	1.25 ± 0.06
14462	0.035 ± 0.003	4.698 ± 0.157	0.303 ± 0.017	50.5 ± 0.8	1.28 ± 0.05
Minimum	0.01	2.44	0.17	47.37	1.01
Maximum	0.11	7.61	1.56	54.57	2.63
Mean	0.04	4.64	0.61	50.31	1.30
SD	0.024	0.884	0.326	1.648	0.293
CV (%)	58.4	19.0	53.1	3.3	22.6

SD, standard deviation; CV, coefficient of variation.
Content expressed as g of dry extract per 100 g of dried kernel for all parameters except O/L.

and mono-gastric animals results in the undigested passage of RFO from the stomach into the large intestine. Raffinose family oligosaccharides undergo anaerobic hydrolysis by micro-flora in the large intestine, leading to production of carbon dioxide, hydrogen, and methane gases, which may cause abdominal discomfort, bloating and flatulence in humans (Tahir et al., 2012). A significant positive correlation of glucose was observed with sucrose which is obvious because glucose is one of the precursors of sucrose. In the present study, a significant positive correlation of sucrose was observed with linoleic acid and negative correlation with O/L ratio (Table 3).

Table 3
Correlation coefficient between analyzed parameters in 60 peanut germplasm.

	Glucose	Sucrose	RFOs	Oil	Oleic acid	Linoleic acid
Glucose						
Sucrose	**0.35****					
RFOs	−0.22	−0.07				
Oil	0.07	−0.12	−0.08			
Oleic acid	0.01	−0.22	0.10	0.25		
Linoleic acid	0.16	**0.33****	0.00	−0.04	**−0.54****	
O/L	−0.16	**−0.36****	0.03	0.11	**0.68****	**−0.95****

** Correlation is significant at the $P < 0.01$ level.

This correlation between sucrose and linoleic acid is undesirable because as sucrose content increases linoleic content will increase resulting in decreased O/L ratio.

3.2. Variation in oil content

Significant variability for oil content was observed among genotypes which ranged between 47.1 and 54.6%. On the basis of oil content, genotype NRCG 14329 was identified for high oil content. However, the CV value was low for oil content indicating less variability among the studied germplasm (Table 2). Hence, in order to improve variability for oil content there is a need for using donors with low oil (<40%) and high oil content (>55%) in our breeding programme. Genotypes with low oil would cater to needs of confectionery products, whereas high oil genotypes could be used for oil extraction. Oil had negative correlation with sucrose and raffinose though it was not significant (Table 3). Similar such negative correlation between oil and sugars has been observed (Chandler and Walter, 2000; Wang et al., 2011). This indicates that altering oil content in breeding programme will not affect composition of sugars and fatty acids (Wang et al., 2012) and vice versa.

3.3. Variation in fatty acid composition

The results of fatty acid profiling revealed that peanut genotypes consisted of 44.0% oleic acid, 34.80% linoleic acid, 14.8% palmitic acid, 3.3% stearic acid and remaining fatty acids constituting about 3.1% (data not shown). Wang et al. (2012) also recorded similar proportions of oleic, linoleic and stearic acid among peanut germplasm accessions. Significant differences were observed among genotypes for four major fatty acids indicating sufficient variability among genotypes for these fatty acids. Oleic and linoleic acid account for 59–92% of total fatty acid. Oleic acid content ranged from 40.3 (NRCG14381) to 51.4% (NRCG14329) and linoleic acid was ranging from 18.70 (NRCG 14471) to 40.60% (NRCG 14334). O/L ratio ranged from 1.01 for NRCG 14334 to 2.63 for NRCG 14472 (Table 2). A higher O/L ratio is an indicator of oil stability, longer shelf-life, and quality of the oils (James and Young, 1983; Branch et al., 1990; Bansal et al., 1993). Moreover, diets containing high levels of monounsaturated fatty acids are as effective in lowering serum cholesterol levels as are low-fat diets (Psaltopoulou et al., 2004). It was possible to identify genotypes with favourable combinations of fatty acids as there was significant variability among genotypes. NRCG 14326 had 51.43% oleic acid, 30.10% linoleic acid and 12.67% palmitic acid whereas NRCG 14471 had lowest linoleic acid (18.40%) but had highest amount of palmitic acid (24.47%). Oleic acid was negatively correlated with linoleic acid and positively with O/L ratio (Table 3) suggesting possibility of increasing oleic acid and O/L ratio by decreasing linoleic acid content. Similar correlation between oleic and linoleic acid was reported by Wang et al. (2011). O/L ratio had negative correlation with sucrose and non-significant positive correlation with oil (Table 3). But Wang et al. (2011) observed non-significant correlation of sucrose with oil. This difference in correlation between two studies may be due to dissimilarity in the genotypes under study.

Table 4
Promising genotypes identified for different traits with high sucrose content.

Contents	High sucrose genotypes (≥5.53 g 100 g^{-1})
Low glucose (<0.017)	14436
Low RFOs (<0.288)	None
Low oil (<48.7)	14381, 14420, 14436
High oil (>51.5)	14351, 14349
High O/L (>1.59)	None

Content expressed as g of dry extract per 100 g of dried kernel for all parameters except O/L.

Table 5
Promising genotypes identified for different traits with Low RFOs content.

Contents	Low RFOs genotypes (<0.288 g 100 g^{-1})
Low glucose (<0.017)	14404, 14456, 14470
High sucrose (>5.53)	None
Low oil (<48.7)	14404, 14461, 14456
High oil (>51.5)	14447, 14470
High O/L (>1.59)	14470

Content expressed as g of dry extract per 100 g of dried kernel for all parameters except O/L.

4. Conclusion

Among sixty Spanish peanut germplasm accessions, few genotypes were identified (Tables 4 and 5) for certain important confectionery traits. The genotype NRCG 14470 was identified for 'low-RFOs, low-glucose, high-oil and high-O/L-ratio' while NRCG 14436 for high-sucrose, low-glucose and low-oil. Hence, these genotypes can be used to study the inheritance of respective traits and further in the peanut improvement programme for developing large-seeded confectionery varieties.

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