NOTE

Effect of Seed Maturity on the Air Classification of Field Peas[1]

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The presence of green-hulled, wrinkled, or shrunken seeds in commercial lots of smooth-seeded, yellow field peas may reduce the overall grade of the seed lot. This low-grade seed constitutes a source of low-cost raw material for the production of starch and protein concentrates from peas by air classification. However, the effects of immature seed on the processing characteristics of otherwise sound field peas have not been determined. Consequently, this study was undertaken to evaluate the impact milling and air classification behavior of field pea samples that differ in their content of immature seed. Of particular interest was the effect of seed maturity on the yield and composition of the air-classified starch and protein fractions.

MATERIALS AND METHODS

Samples

Yellow field peas (*Pisum sativum* L. cv. Trapper) were grown in two replications of a randomized complete block design at Conquest, Saskatchewan, in 1981. Treatments consisted of windrowing plants (approximately 0.1 ha per treatment) at four stages of maturity. The first cut was performed when all pods were completely filled but showed no sign of ripening, the second and third when approximately 50 and 100%, respectively, of the pods had yellowed, and the fourth when the plant was completely ripened. The four cutting dates corresponded to 79, 86, 91, and 97 days after seeding, and 61.0, 49.7, 20.4, and 14.5% moisture in hand-shelled seed, respectively. For all treatments, the swathed grain was allowed to dry in the field before it was threshed.

Processing

Samples (containing 8–10% moisture) were milled at feed rates of 225–250 kg/hr in an Alpine 250 CW pin mill (Alpine Corp., Augsburg, West Germany) with counter-rotating disks operating at 6,000 and 11,500 rpm. The flours were then fractionated into coarse (starch-rich) and fine (protein-rich) fractions using an Alpine 132 MP air classifier at feed rates of 40–45 kg/hr, a rotor speed of 11,000 rpm, and a vane setting of 20. The coarse fractions were remilled at feed rates of 95–105 kg/hr and classified at feed rates of 35–40 kg/hr into more highly purified starch-rich fractions (SF) and a second set of protein-rich fractions. For each sample, the fine fractions from the first and second classifications were combined to form a single protein-rich fraction (PF).

[1]Paper No. 22726 from the National Research Council of Canada.

Analytical Methods

Seed size (1,000-seed weight) was determined on moisture-free material dried in vacuo at 80°C. Calculations were based on the average weight of four samples of 100 seeds.

Moisture and protein were determined by AACC (1969) procedures, and starch by a modification of the method of Banks et al (1970) as described by Reichert (1981).

An Agtron M500A reflectance spectrometer (Magnuson Engineers Inc., San Jose, CA) was used to assess the color of the pin-milled flours, starch fractions, and protein fractions. Flours from dehulled peas were also analyzed. Dehulling was accomplished in a laboratory-scale abrasive dehuller (TADD) described by Oomah et al (1981), and flours produced by grinding the dehulled seed in a model 1092 Cyclotec sample mill (Udy Corp., Boulder, CO) equipped with a 1-mm screen. The flours and air-classified fractions were evaluated as thin pastes, prepared by mixing 4 g of powder with 6 (flours), 7 (starch fractions), or 8 ml (protein fractions) of water. Reflectance values at each of 436, 546, 585, and 640 nm were averaged to provide a single color value for each sample.

Starch separation efficiency, the percentage of the total flour starch recovered in the SF, and protein separation efficiency, the percentage of the total flour protein recovered in the PF, were calculated as described by Tyler et al (1981). Data were subjected to analysis of variance and Duncan's multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

Selected physical and chemical characteristics of field peas harvested at four stages of maturity are presented in Table I. Peas

TABLE I
Characteristics of Field Peas Harvested at Four Stages of Maturity[a]

Sample[b]	Seed Size (g/1,000)	Reflectance		Protein[c] (%)	Starch (%)
		Whole	Dehulled		
1	110 a	37.0 a	41.4 a	29.1 a	44.6 a
2	135 b	41.5 b	44.4 b	24.7 b	46.4 ab
3	132 b	43.1 c	45.6 c	24.7 b	47.4 ab
4	142 c	44.4 d	45.4 c	23.9 b	49.2 b

[a]Values are the average of two determinations on each of two replicates and expressed on a moisture-free basis. Means within columns followed by the same letter are not significantly different at $P > 0.05$.
[b]Samples 1, 2, 3, and 4 were harvested at 79, 86, 91, and 97 days after seeding, respectively.
[c]Percent N × 6.25.

TABLE II
Air-Classification Data for Field Peas Harvested at Four Stages of Maturity[a]

Sample[b]	Yield (%) of		Protein (%) in		Starch (%) in		SSE	PSE	Reflectance	
	SF	PF	SF	PF	SF	PF	(%)	(%)	SF	PF
1	59.5 a	40.5 a	6.6 a	59.0 a	70.2 a	5.4 a	95.1 a	86.7 a	50.3 a	80.6 a
2	63.2 b	36.8 b	4.9 a	54.8 b	74.9 ab	4.8 a	96.2 a	87.5 a	54.9 b	81.3 ab
3	62.2 b	37.8 b	4.9 a	54.6 b	76.1 ab	5.1 a	95.9 a	87.4 a	55.7 c	81.7 b
4	62.2 b	37.8 b	4.5 a	54.2 b	78.7 b	5.0 a	96.1 a	88.3 a	58.5 d	82.9 c

[a] Values are the average of two determinations on each of two replicates, with the exception of yield values, which are the average of single determinations on each of two replicates. All values are expressed on a moisture-free basis. Means within columns followed by the same letter are not significantly different at $P > 0.05$.

[b] Samples 1, 2, 3, and 4 were harvested at 79, 86, 91, and 97 days after seeding, respectively.

from the earliest harvest varied considerably in size. Many small seeds were present, and a large portion of these were wrinkled or shrunken. The 1,000-seed weight, therefore, was markedly lower for peas from the first harvest, but increased only slightly after the second cutting. Similar trends were observed for reflectance (color) values since early-harvested samples contained many green-hulled seeds, in contrast to those harvested at or near maturity, which were essentially devoid of green seed. Increases in reflectance for both whole and dehulled peas indicated that color in both the hull and the cotyledon changed during the latter stages of seed development. Peas from the earliest harvest were higher in protein and lower in starch than those harvested at more advanced stages of maturity.

Air classification data are presented in Table II. The yield of the SF was lowest and, consequently, that of the PF highest, for peas from the earliest harvest. In addition, peas from the first harvest yielded a PF higher in protein than those from later cuttings and an SF lower in starch than that from the fourth cutting. The stage of seed development at harvest did not significantly affect either the protein content of the SF or the starch content of the PF. Starch separation efficiency was also not affected by seed maturity. Since starch granule size increases during the course of seed development (Biliaderis 1982), granules were either fully developed at the time of the earliest harvest or, if immature, sufficiently large to be retained in the SF as effectively as those in peas from later cuttings. Protein separation efficiency was similarly unaffected by seed maturity, which suggests that milling efficiency was similar for all samples regardless of cutting date. As a result, the lower SF and higher PF yields obtained for peas from the earliest harvest probably paralleled the starch and protein contents, respectively, of the peas, as did the starch content of the SF and the protein content of the PF (Tyler et al 1981), rather than differences in impact milling efficiency. Reflectance values for the SF and the PF paralleled those for whole and dehulled peas, respectively, since hull material from whole peas is concentrated in the coarse, air-classified fraction (Vose et al 1976).

In conclusion, the presence of immature seed in samples of field peas, even at the high levels experienced with peas from the earliest harvest, had little effect on their impact milling and air classification characteristics. Consequently, the levels normally experienced in commercial lots would not be expected to affect their dry processing characteristics. One concern, however, is the effect of seed size and shape on the dehulling of peas. Dehulling before milling and classification may be employed to prevent the concentration of fibrous and sometimes dark hull material in the coarse fraction (Vose et al 1976, Youngs 1975). However, the presence of green, small, or shrunken seed may make efficient dehulling difficult or impossible by either splitting (attrition) or abrasion techniques, and may translate into undesirably high fiber levels in the starch-rich fraction and a loss of purified hull material. Indeed, data (unpublished) from this laboratory and from commercial practice[2] have shown this to be the case. In addition, the effect of seed maturity on the color, flavor, and functionality of air-classified fractions would be of particular interest where such fractions are intended for food use.

[2] Personal communications with Morton and Gerry Satin, Pro-Star Mills Ltd., Saskatoon, SK. 1983.

ACKNOWLEDGMENT

We thank D. Dymond for expert technical assistance.

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[Received September 7, 1983. Accepted November 4, 1983]