Foreign Material Extractors for Peanut Flowpipes

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ABSTRACT

Foreign material extractors were installed and evaluated in farmers stock peanut flowpipes during the harvest seasons of 1978, 1979, and 1980. Three of the extractors evaluated were commercially available and consisted of a stationary, inclined screen manufactured by Suffolk Iron Works, Inc., Suffolk, VA; an inclined, mechanical tumbler-extractor manufactured by Hobbs-Adams Engineering Company, Suffolk, VA; and an inclined, mechanical roller screen manufactured by Bev. Mathison's Spring Works, Warwick, Queensland, Australia. Two additional experimental extractors including a stationary, inclined screen and an aspirator were also tested along with aspiration hoods used in conjunction with the commercial extractors. The weight per tonne (t) of peanuts of foreign materials removed by the various extractors ranged from 0.8 kg to 21.3 kg. Aspiration generally doubled the amount of foreign materials removed by the extractors. The primary materials removed by the extractors were dirt, peanut stems, sticks, leaves, small rocks, and some broken or loose shelled peanut meats.

Key Words: Foreign materials, extractor, peanuts, cleaning, separation, storage.

In the U.S.A., most commercially grown peanuts are stored for varying lengths of time in 2100 to 4500 tonne capacity warehouses before shelling and processing. Peanuts with less than 10% foreign material are usually stored without precleaning and the accompanying foreign materials not only occupy storage space but also produce undesirable storage environments (1, 2, 3, 4, 5, 6, 7). Removal of some or all foreign materials from peanuts before storage would provide additional storage space and a more desirable storage environment for maintaining quality (4,5,6). However, because of the volume of peanuts which must be handled during the harvest season (4-6 weeks) and the required cleaning equipment and manpower, cleaning all peanuts before storage is not currently feasible with full-scale cleaners.

An alternative to cleaning before storage with full-scale cleaners is partial cleaning low-cost, high capacity, foreign material extractors. Foreign material extractors are designed for installation in elevator downspouts and peanut flowpipes. The extractors are advertised to handle required flowrates and to remove certain types of foreign materials such as dirt and fines that restrict air movement through the peanuts and resulting thermal and moisture equilibration. These foreign materials are concentrated in the peanuts directly beneath the conveying equipment used to fill the warehouse (3,4,5,6,7).

The objectives of this research were to evaluate commercial and experimental foreign material extractors and to develop and evaluate modifications of the extractors to provide improvements.

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Materials and Methods

Cleaning experiments with foreign material extractors were conducted during 1978, 1979, and 1980 harvest seasons. In 1978, 5 different extractors were installed on the downspouts of 5 separate bucket elevators at warehouses owned by the Damascus Peanut Company, Incorporated, Damascus, GA. Three of the extractors were commercially available and two were designed by National Peanut Research Laboratory (NPRL) staff. The commercial extractors installed were a Model 132 Extractor (H-A-132) built by Hobbs-Adams Engineering Company, Suffolk, VA; a Model 20-120 Dirt Extractor (SIW-20-120) built by Suffolk Iron Works, Incorporated, Suffolk, VA; and a Type D, Jacobs Roller Screen (JRS-D) built by Bev. Mathison's Spring Works, Warwick, Queensland, Australia. The NPRL designed extractors were a 0.55 m wide x 3.05 m long, fixed, inclined screen with a perforated grate (NPRL-IS) and an aspiration system (NPRL-A) attached to the top of an existing rectangular downspout. Automated insecticide application systems (8) were designed for installation down stream of the extractors. Fourteen replications of 5 sample, 4.3 t Florunner peanut tests of comparable quality were conducted. Each of the 5 tests was run through separate extractors (one load for each extractor) to determine the efficiencies of the extractors for removing foreign materials from peanuts as they flowed into a warehouse. All 5 tests of a replication were moved into the warehouses during a 24-hour period. Peanut flowrates, grades, load weights and the volume and weight of extracted foreign material (EFM) removed from each load were recorded.

Based on the relative performances of the five extractors, modifications of the SIW-20-120, JRS-D, and H-A-132 extractors were formulated for testing the succeeding two years. The NPRL-IS was omitted because it did not provide any performance characteristics better than the commercially available extractors. Modifications for improving the 3 commercial extractors consisted of incorporating a hood at the end of each extractor to provide the option of aspiration. Also, Suffolk Iron Works redesigned the screen for the SIW-20-120 extractor to improve both separation and self-cleaning. An attempt was also made to improve the JRS-D extractor design by widening and lengthening the separation area.

In 1979, the 3 extractors were installed above a transfer bin on downspouts of a single elevator at a peanut drying and purchasing facility owned by Cargill, Incorporated and located at Parrott, GA. Installed were a H-A-132, a SIW-20-120 with a redesigned screen and a roller screen similar to but larger than the JRS-D. A 15.2 cm deep x 1.2 m wide x 1.5 m high aspiration hood was attached to the bottom end of each of the extractors and evaluated for use in combination with the extractors. Peanuts were obtained from farms selected by Cargill Incorporated. Ten replications using 4.3 t average tests per replication were conducted using all three extractors with aspiration hoods operating. Two replications were conducted with aspiration hoods not operating. Mechanical difficulties with the roller screen limited the number of replications conducted with all 3 extractor systems operating. Fifty-three additional replications of 2, 4.3 t tests were run without the roller screen system, 6 with and 47 without aspiration. Test procedures and data collection were similar to 1978 tests except EFM volumes were not obtained. Sub-samples of the extracted foreign material were collected for determination of oil content.

In 1980, the H-A-132 and SIW-20-120 were used as in 1979 but the roller screen was dropped because of mechanical difficulties. Fourteen replications were conducted with each extractor, 5 with and 9 without aspiration.

Results and Discussion

Statistical comparisons of mean relative flowrate, extracted foreign material volume and weight for the extractors evaluated in 1978 are presented in Table 1. Mean official grade foreign material percentages of the test samples run through the extractors were not significantly different and ranged from 1 to 6 percent with an overall mean of 3% and a variance of 1.7%. Even though there were significant differences between mean flowrate for the extractors (Table 1), flowrate could not be separated as a contributing factor to the differences in extracted foreign material volumes or weights within the range of flowrates tested. The NPRL-A extractor removed significantly larger volumes of foreign materials than the other extractors; however, the mean EFM weight for the NPRL-A extractor was not statistically higher than the mean EFM weights of the H-A-132 or JRS-D extractors (Table 1). The H-A-132 extractor removed larger weights of foreign materials than the SIW-20-120 and NPRL-IS extractors.

Table 1. Comparison of mean flowrates, EFM volumes, and weights for the 1978 experiments.

Extractor	Flowrate (t/h)	Extracted Foreign Material: Volume (l/t of peanuts)	Extracted Foreign Material: Weight (kg/t of peanuts)
SIW-20-120	24.0 c*	1.4 c	0.8 b
JRS-D	35.6 a	3.6 b	1.6 ab
H-A-132	27.8 b	4.2 b	2.4 a
NPRL-IS	23.3 c	1.6 c	1.2 b
NPRL-A	37.6 a	12.0 a	1.8 ab

*Means in each column followed by the same letter are not significantly different at the 0.05 level.

An evaluation of the types of materials being removed by the extractors during 1978 is presented in Table 2. All of the extractors except the NPRL-A removed more dirt than the other listed materials. The NPRL-A removed 6.9% more sticks and light trash than dirt. All of the extractors removed some loose shelled kernels or meats; however, the JRS-D removed consistently higher weights of meats than the other extractors (Table 2). Some clogging was experienced on the downspouts and screen openings of the SIW-20-120. All of the extractors, except the NPRL-A removed a considerable number of live insects. Removal of live insects would reduce insect damage during storage. Insecticide application used in conjuncation with an extractor should be made after the peanuts have passed through the extractor to prevent clogging of the separation area.

Table 2. Comparisons of the mean compositions of foreign material samples extracted during the 1978 experiments.

Extractor	Dirt (%[1])	Light Trash (%)	Rocks (%)	Rocks & Meats[3] (%)	Meats[4] (%)
SIW-20-120	79.7 b[2]	11.0 c	1.1 a	5.2 a	2.8 b
JRS-D	65.4 c	15.4 b	1.5 a	4.4 a	12.6 a
H-A-132	88.1 a	6.0 d	0 b	0 b	4.8 b
NPRL-IS	93.6 a	4.5 d	0.9 a	0 b	0.4 b
NPRL-A	44.6 d	51.5 a	0 b	0 b	2.9 b

[1]Percent by weight.

[2]Means in each column followed by the same letter are not significantly different at the 0.05 level.

[3]This separation composed of broken pieces of peanut kernels and rocks that fell through a 4.8 mm x 12.7 mm slotted screen.

[4]Loose shelled peanut kernels or kernel halves.

A comparison of mean flowrates and EFM weights with and without aspiration for the extractors for the 1979 and 1980 tests are presented in Table 3. Mechanical difficulties with the JRS-D extractor prevented adequate testing for statistical comparisons with the other two extractors. The means shown in Table 3 for this extractor are averages of 10 runs with aspiration and 2 without during 1979. The results indicate that the design of this extractor is very promising and additional testing warranted; however, the mechanical difficulties could not be resolved and the statistical comparisons made in Table 3 do not include the JRS-D extractor. Official grade foreign material percentages and flowrate were not significantly different by year for the extractors during the 1979 and 1980 tests. Aspiration increased mean EFM weight by 2.3 times for the SIW-20-120 extractor in 1979 and by 1.4 times in 1980 (Table 3). Similarly, the performance of the H-A-132 extractor was improved by factors of 2.2 and 1.7 times for 1979 and 1980 tests, respectively.

Table 3. Comparison of the mean flowrate and EFM weights for the 1979 and 1980 experiments.

Extractor	Year	Aspiration	Flowrate[1] (t/hr)	Mean Extracted Foreign Material Weight (kg/t)
SIW-20-120	1979	No	36.3 a	6.9 b
		Yes	35.5 a	15.9 a
	1980	No	38.1 a	8.2 b
		Yes	37.5 a	11.1 ab
H-A-132	1979	No	35.8 a	7.5 b
		Yes	36.0 a	16.8 a
	1980	No	37.6 a	6.5 ab
		Yes	39.0 a	11.0 ab
JRS[2] (redesigned)	1979	No	37.3	15.2
		Yes	37.5	21.3

[1]Means in each column followed by the same letter are not significantly different at the 0.05 level.

[2]Statistical comparisons could not be made because of insufficient replication.

An analysis of the composition of EFM subsamples for the 1979 tests is presented in Table 4. When operating with aspiration, foreign materials were collected at both the cyclone attached to the aspiration hood and the EFM discharge of the extractor. Aspiration altered the composition of foreign materials removed by the extractors. Light materials increased 17-23 percent by weight with aspiration. An analysis of the oil content of the rocks and meats foreign material classification averaged 5.5% without aspiration and 12.8% with aspiration. No significant differences between extractors were observed in the oil content results.

Table 4. Comparison of the compositions of foreign material subsamples extracted during 1979 experiments.

Extractor	Dirt (%)	Light trash (%)	Rocks (%)	Rocks & Meats (%)	Meats (%)
SIW-20-120					
With aspiration	56.3 b[1]	37.5 a	0.2 b	3.6 a	2.3 a
Without aspiration	78.8 b	15.8 b	0.3 b	3.8 a	1.3 a
H-A-132					
With aspiration	62.5 b	26.5 a	0.5 b	7.2 b	3.2 a
Without aspiration	89.5 a	3.8 b	0.2 b	5.7 b	0.7 a
JRS-D[2]					
With aspiration	63.5	22.7	1.9	8.3	3.6
Without aspiration	84.3	5.5	2.1	7.2	0.9

[1]Means in each column followed by the same letter are not significantly different at the 0.05 level.

[2]Statistical comparisons could not be made because of insufficient replication.

The design of the H-A-132 extractor without aspiration remained unchanged during all three years of testing. The mean EFM weights for the three years were 2.4 kg/t for 1978, 7.5 kg/t for 1979, and 6.5 kg/t for 1980 for this extractor (Tables 1 and 3). We believe differences in EFM weights between years were influenced by differences in growing and harvesting conditions, (i.e., weather and soil conditions during growing and harvesting). Comparing the performance of the extractors between years showed little differences occurred in the total weight of foreign materials removed. However, differences in the types or composition of foreign materials removed was observed. The amount of foreign material removed by the extractors tested was essentially doubled by adding an aspiration hood. Because of the type and amount of foreign materials and insects removed, installation of extractors in warehouse feed pipes should enhance storability of peanuts in warehouses.

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