Peanut Science (1980) 7, 38-40

Pressing Peanuts with a Ring-Cage Screw Press[1]

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ABSTRACT

A ring-cage screw press was examined as a means of reducing protein insolublization and chemical browning of peanut protein during prepressing of peanuts. It was found possible to prepress uncooked peanuts with moderate heat exposure. Effects of conditioning temperature, screw press pressure and screw press temperature on quality of peanut flour were surveyed. Some protein damage occurred during conditioning but the greatest amount of protein insolublization occurred during screw pressing. The rate of post screw press cooling had little effect on protein solubility. The ring-cage screw press was able to press conditioned peanuts to 5-10% residual oil with less heat damage than occurs in cooking and screw pressing, as commercially practiced. Improved pressing conditions for producing food-grade peanut flour using the ring-cage screw press were identified as conditioning seed to 60°C within 6 min. and pressing at 60°C. Increased soluble protein and less chemical browning resulted in ring-cage screw pressed, solvent extracted flour than occurring in conventionally processed peanut flour.

Key Words: peanut, peanut flour, screw-pressing, prepress, ring-cage screw press.

Approximately 57% of the world's peanut production is crushed. Peanut oil is the primary valued product, while the defatted meal is generally marketed as animal feed with much less value. Oil removal is generally accomplished by screw pressing or prepress, solvent extraction using screw presses with cages of bars. This type of screw press functions best when peanuts have been adjusted to 10% moisture and cooked to 115°C over 45-60 min. to produce material sufficiently pliable for pressing (2). Typically, operating conditions of screw presses are controlled to maximize capacity of the press consistent with producing press cake having characteristics suitable for efficient solvent extraction. The cooking operation, as well as, high pressure and heat generated during normal screw pressing, darkens color and reduces solubility of peanut protein in water. Protein solubility may be as low as 58-60% (3) indicating the meal protein is extensively denatured. The protein is unsuitable for many food uses and is normally relegated to livestock feed.

Preliminary intermittent trials have indicated that a ring-cage screw press can press peanuts with less severe exposure to heat during preparation and pressing. This may reduce insolubilization of peanut protein and chemical browning that occur during conventional crushing of peanuts. Peanut flour with improved protein solubility and lighter color would be more suitable for food applications. The objective of this study was to evaluate the effects of heat during ring-cage screw pressing of peanuts.

[1]This paper reports findings of research funded by the Natural Fibers and Food Protein Commission of Texas.

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Materials and Methods

Crushing Stock

Approximately 1200 kg of United States Number 1 Southwest Spanish peanuts were used in this study. The peanuts were heated for 5 min. at 98°C in a Proctor and Swartz Variable Circulation Dryer with through-bed air circulation to loosen skins. The nuts were blanched in a Bauer Split Nut Blancher to remove skins and hearts.

Processing

The peanuts were conditioned in a steam-jacketed Schnecken tube to the desired temperature. The peanuts were continuously fed to the Schnecken tube using a vibratory feeder at the rate of 80 kg/hr. Although moisture is known to affect pressing efficiency (6), no added moisture or sparge steam were used and the nuts were pressed at their natural moisture content (5.6-6.1%) without milling. The temperature of the nuts as they exited the conditioning tube was reported as the feed temperature to the screw press. Residence time for conditioning in the Schnecken tube was 6 min.

The conditioned seed was pressed in an Ozawa continuous, vertical ring-cage expeller (Chuo Giken Kogyo Co. Ltd., Chuo-ku, Japan). Temperature within the press cage was controlled by adjusting the temperature of the circulating oil flowing over the outside of the cage. Energy balances indicated the temperature of the circulating oil approximated (±2°C) the cake temperature within the screw press. The unit was allowed to equilibrate for 15 min. at each condition to achieve steady-state operation. The press cake was extracted to less than 1% oil with hexane. After desolventization the meal was ground to flour.

Analytical

Nitrogen solubility index (NSI), total nitrogen, moisture and residual oil were determined by standard AOCS procedures (1). Protein content was estimated using a nitrogen conversion factor of 5.46. Color parameters were evaluated using the Hunter Color Difference Meter with dry peanut flour and flour wetted with water at the ratio of 1:2 (w:w). Whiteness indices were calculated according to the equation of Hunter (7) where higher numbers indicate whiter colors.

$$W = 100 - \sqrt{(100-L)^2 + a^2 + b^2}$$

Results and Discussion

Pressing Uncooked Peanuts

The Ozawa ring-cage screw press has been observed to be able to press oil from various oil-bearing seeds which based on experience were considered unpressable with conventional screw presses (5). In a preliminary run the Ozawa ring-cage screw press was found to form good press

Table 1. Pressing peanuts with the ring-cage screw press.

Seed In:	
Moisture (%)	6.6
Oil (%)	48.6
Nitrogen Solubility Index (%)	98.3
Pressing Conditions:	
Feed Rate (kg/hr)	80
Conditioning Time (min)	6
Moisture Addition (kg/kg seed)	0
Seed Temperature Exit Conditioner (°C)	77
Circulating Oil Temperature (°C)	88
Cake:	
Thickness (mm)	2.7
Residual Oil (%)	7.0
Defatted Meal:	
Oil (%)	0.5
Protein (%)	55.6
Whiteness Index	83.8
Nitrogen Solubility Index	85.3

cake from uncooked peanuts which were merely heated to 77°C in 6 min. (Table 1). This is a significant observation since conventional screw presses require peanuts to be cooked with added moisture at relatively high temperatures in order to produce press cake, which results in considerable protein insolubization. In this initial run the press cake contained 7% residual oil while the defatted meal retained 85.3% soluble nitrogen. Typically, about 60% of the nitrogen of peanut flour remains water soluble when produced by current commercial practices (3). Although peanut proteins are relatively heat stable (4, 8-10) considerable protein denaturation and insolublization occur during oil recovery.

The Ozawa ring-cage screw press will make press cake and express oil from peanuts which are not sufficiently changed by heat treatment to allow formation of press cake by conventional screw presses. Rings forming the cage of the Ozawa screw press encircle the screw and, presumably, joints between rings offer more frictional resistance to flow of solids than occurs in conventional screw presses. This allows pressure to develop with materials which otherwise do not form press cake. The cage of a conventional screw press is formed by bars which run parallel to the screw and offer less resistance to flow. Pressure is difficult to develop in a conventional screw press unless the material has been sufficiently denatured to reduce plasticity.

Protein Insolublization During Conditioning and Pressing

Heat treatment phases in prepressing of peanuts using the ring-cage screw press were examined to understand time-temperature relationships upon protein insolublization during conditioning, screw pressing, and cooling of press cake. The extent of protein insolublization increased as conditioning temperature increased (Table 2). The NSI was reduced from 97.9% to 95.8% when the seed was conditioned to 60°C and to 92.8% when conditioned to 74°C. Using peanuts conditioned to 60°C with an NSI of 95.8%, pressing at 96°C reduced the NSI to 88% whereas peanuts pressed at 74°C had an NSI of 94.4% immediately after pressing. One might expect the greatest loss of protein solubility to occur during the very slow cooling of press cake after pressing. However, on an average basis of three samples, NSI did not change during cooling of press cake. These data indicated the greatest reduction of NSI in the ring-cage screw press process was in the pressing operation.

Table 2. Effect of conditioning and pressing parameters on characteristics of the press cake.

Low Pressure[1]						
Feed Temperature (°C)	32	32	49	60	60	74
Screw Press Temperature (°C)	60	96	77	60	77	96
Residual Oil (%)	lost[4]	lost[4]	7.1	6.1	7.3	6.7
NSI (%)	lost[4]	lost[4]	85.5	85.8	84.9	84.[illegible]
Whiteness Index Dry	lost[4]	lost[4]	83.4	83.9	83.1	83.6
High Pressure[2]						
Feed Temperature (°C)	32	32	49	60	-	74
Screw Press Temperature (°C)	60	96	77	60	-	96
Residual Oil (%)	lost[4]	9.9	5.7	5.0	-	5.2
NSI (%)	lost[4]	86.3	84.6	84.6	-	82.7
Whiteness Index Dry	lost[4]	84.0	83.8	83.0	-	83.7

[1] High pressure - screw setting out 10.8 cm.

[2] Low pressure - screw setting out 11.4 cm.

[3] Screw press temperature - determined from the temperature of the circulating oil over the press cage.

[4] Lost - denotes cake formation could not be maintained during screw pressing.

Minimizing Heat Treatment During Screw Pressing

Temperature and time of seed conditioning and temperature, time and pressure of screw pressing affect the efficiency that oil is pressed and that protein is denatured. The effects of these parameters on residual oil in the press cake, protein solubility and color of the flour were evaluated (Table 2). In this series of experiments the blanched peanuts contained 6.3% moisture, 48.9% oil and 28.6% protein with 96.4% soluble nitrogen. Since each run consumed about 150 kg of seed, a factorial experimental design of all factors which affect screw press operation or replication of process conditions could not be accomplished. Therefore, the scope of this work was limited to a feasibility study of reducing the effects of those operating parameters most likely to affect protein insolublization, chemical browning and residual oil in the cake. The lowest conditioning temperature that maintained acceptable pressing conditions was 32°C when the press cage was maintained at 96°C. The press cake retained 9.9% oil and protein with an NSI value of 86.3%. The lowest acceptable press cage temperature was 60°C with seed conditioned to 60°C. Residual oil content of the press cake was 6.1% with the protein in the defatted meal having an NSI value of 85.8%. Although the range of NSI values was only 82.7 to 86.3%, NSI slightly decreased as the heat treatment became more severe. Operating conditions had little affect on color of the defatted flour. Whiteness values ranged from 83.0 to 84.0. Increasing expelling pressure reduced residual oil content of the cake but had little affect on NSI of the protein and color of the flour.

Peanut flour prepressed with the Ozawa ring-cage screw press was much improved over commercial peanut flour (Table 3). There was some

Table 3. Characteristics of experimental and commercial peanut flours.

Analysis	Optimum Experimental	Commercial
Residual Oil (%)	0.3	0.8
Protein (%)	54.5	52.8
NSI	86.3	68.1
Whiteness Index Dry	83.9	78.7
Whiteness Index Wet	73.1	64.4

question whether screw pressing at 96ºC of peanuts conditioned to 32ºC could sustain adequate formation of press cake under continuous operation. Therefore, improved conditions for operating the ring-cage screw press were: conditioning peanuts at 5-6% moisture to 60ºC over 6 min., and pressing at 60ºC under low pressure. These conditions resulted in 6.1% residual oil in the cake. These improved conditions may be affected by moisture content of the feed stock and some adjustment may be required for pressing peanuts of different moisture contents. The quality of peanut flour was greatly improved over conventional prepressed, solvent-extracted peanut flour. The NSI was 86.3% for the optimum experimental flour versus 68.1% for a commercial peanut flour. Color of the experimental flour exhibited less chemical browning, having a whiteness index about 5 units higher than the commercial flour. By eliminating the cooking of seed, which was facilitated by using a ring-cage screw press and reducing the severity of heat treatment during pressing, physical and functional properties of peanut protein of prepressed, solvent extracted peanut flour were improved. These improved characteristics may increase the potential for peanut flour as a food ingredient. The deletion of tempering, cooking and milling of peanuts prior to prepressing should also reduce energy inputs to oil milling.

Literature Cited

1. AOCS. 1971. "Official and Tentative Methods", 3rd ed. American Oil Chemists' Society, Chicago, IL.

2. Ayres, J. L., L. L. Branscomb and G. M. Rodgers. 1974. Processing of edible peanut flour and grits. J. Am. Oil Chem. Soc. 51:133-136.

3. Ayres, J. L. and B. L. Davenport. 1977. Peanut protein: A versatile food ingredient. J. Am. Oil Chem. Soc. 54:109A-111A.

4. Cherry, J. P., K. M. McWatters and M. R. Holmes. 1975. Effects of moist heat on solubility and structural components of peanut proteins. J. Food Sci. 40:1199-1204.

5. Clark, S. P., P. J. Wan and S. W. Matlock. 1980. Pilot-plant production of sunflower seed flour. J. Am. Oil Chem. Soc. (in press).

6. Harris, H., E. Y. Davis, M. S. Van de Mark, K. S. Rymal and J. J. Spadaro. 1972. Development and use of defatted peanut flours, meals and grits. Bulletin 431. Agricultural Experiment Station, Auburn University, Auburn, AL.

7. Hunter, R. S 1958. Description and measurement of white surfaces. J. Opt. Soc. Am. 48597-605.

8. Neucere, N. J., R. L. Ory and W. B. Carney. 1969. Effect of roasting on the stability of peanut proteins. J. Agri. Food Chem. 17:25-28.

9. Neucere, N. J. 1972. Effect of heat on peanut proteins. I. Solubility properties and immunochemical-electrophoretic modifications. J. Agri. Food Chem. 20:252-255.

10. Ory, R. L., N. J. Neucere, R. Singh and A. J. St. Angelo. 1970. Stability of the peanut proteins to heat and organic solvents. J. Amer. Peanut Res. Educ. Assoc. 2:119-127.

Accepted March 18, 1980