Privett, O. S.; Dougherty, K. A.; Erdahl, W. L.; Stolyhwo, A. *J. Am. Oil Chem. Soc.* **1973**, *50*, 516.
Roehm, J. N.; Privett, O. S. *Lipids* **1970**, *5*, 353.
Rubel, A.; Rinne, R. W.; Canvin, D. T. *Crop Sci.* **1972**, *12*, 739.
Singh, B. B.; Hadley, H. H. *Crop Sci.* **1968**, *8*, 622.
Smith, A. K.; Circle, S. J. In *Soybean: Chemistry and Technology*; Avi Publishing Co.; Westport, CT, 1972; p 61.
Stearns, E. M., Jr. In *Progress in the Chemistry of Fats and Other Lipids*; Holman, R. I., Ed.; Pergamon Press: New York, 1971; p 453.
Urbanski, G. E.; Wei, L. S.; Nelson, A. I. *J. Food Sci.* **1980**, *45*, 208.
Yao, J. J.; Wei, L. S.; Steinberg, M. P. *J. Am. Oil Chem. Soc.* **1983**, *60*, 1245 and literature cited therein.
Yazadi-Samadi, B.; Rinne, R. W.; Seif, R. D. *Argon. J.* **1977**, *69*, 481.

Received for review April 15, 1985. Revised manuscript received October 7, 1985. Accepted February 8, 1986.

Effect of Processing on Available Carbohydrates in Legumes

Sudesh Jood, Usha Mehta,* and Randhir Singh

The effect of various treatments such as (i) soaking in plain water and sodium bicarbonate solution, (ii) cooking of soaked seeds, (iii) autoclaving of soaked seeds, (iv) germination, and (v) frying of germinated seeds, commonly employed to destroy the flatulence factors in legumes, was investigated on available carbohydrates of Rajmah (*Phaseolus vulgaris*), Bengal gram (*Cicer arietinum*), black gram (*Phaseolus mungo*), red gram (*Cajanus cajan*), and broad bean (*Vicia faba*). Total soluble sugars, reducing sugars, nonreducing sugars, and starch content in above pulses ranged from 7.09 to 10.33%, 0.18 to 0.83%, 6.91 to 9.60%, and 43 to 53%, respectively. The contents of all these components decreased under various treatments. However, on germination for 24 h, the losses in the amount of total sugars, reducing sugars, and nonreducing sugars were higher than observed in seeds germinated for 48 h. On further germination up to 96 h, the contents of these sugars increased. Starch content, on the other hand, decreased. When the present observations are combined with those of a previous paper, it appears that germination of pulses for 24 h is a reasonably good treatment for reduction of flatus-producing carbohydrates as well as avoiding excess losses of the available carbohydrates.

Legumes, widely grown and consumed throughout the world, are excellent sources of proteins (20–40%) and carbohydrates (50–60%) and fairly good sources of thiamine, niacin, calcium, and iron (Aykroyd and Doughty, 1977). However, their wide acceptability is affected adversely due to the presence of flatulence factors as well as other antinutritional factors. Unavailable carbohydrates (15–25%) include substantial levels of oligosaccharides of the raffinose family of sugars (raffinose, stachyose, verbascose), which are well-known to produce flatulence in man and animals (Rackis, 1975; Olson et al., 1975; Reddy et al., 1980). Various processing methods have been tried to reduce the effect of these undesirable carbohydrates as well as to improve the digestibility of available carbohydrates in a variety of legumes (Iyengar and Kulkarni, 1977; Rao and Belavady, 1978; Reddy and Salunkhe, 1980; Reddy et al., 1980). In our previous paper (Jood et al., 1985), we reported the effect of common processing techniques on the contents of flatus-producing carbohydrates and recommended that germination for 24 h is the most suitable treatment for better utilization of legumes. However, all the methods described also affect the contents of available carbohydrates. Therefore, we report here the effect of those methods on the contents of available carbohydrates.

MATERIALS AND METHODS

Samples of five common legumes, Rajmah (*Phaseolus vulgaris*), Bengal gram (Cicer *arietinum*), black gram (*Phaseolus mungo*), red gram (*Cajanus cajan*), and broad bean (*Vicia faba*), were obtained from the Department of Plant Breeding, Haryana Agricultural University, Hissar, India.

Processing. The traditional methods of cooking legumes as described earlier (Jood et al., 1985) were followed in this investigation also. The samples were soaked in plain water and sodium bicarbonate solution (0.03%) for 6- and 12- h period at 25 °C. The samples thus soaked were cooked by boiling in water (4 times by weight) and autoclaved at 15 psi in double the amount of water. The soaked water was decanted before cooking. The samples to be germinated were surface sterilized with 1% sodium hypochlorite solution, washed thoroughly with distilled water, and placed at 30 °C on a damp filter paper and subjected to analysis at 24, 48, 72, and 96 h of germination. The 24-h germinated samples were shallow fried for 10 min in hydrogenated vegetable oil on a naked flame. The samples thus processed were dried at 80 °C in hot air oven until constant weight (48 h), ground in an electric grinder to pass through a 100-mesh sieve, and stored in an air-tight polyethylene bottle at room temperature (25 °C) until further analysis. The various antlytical procedures used were as follows:

The total water-soluble sugars were extracted according to the method of Cerning and Guilbot (1973). Starch was extracted from the sugar-free pellet by the method of Clegg (1956). Quantitative determination of total soluble sugars and starch was carried out according to the method of Yemm and Willis (1954). Reducing sugars were estimated by Somogyi's modified method (Nelson, 1944; Somogyi, 1945), and nonreducing sugars were estimated by calculating the difference between total soluble sugars and reducing sugars.

RESULTS AND DISCUSSION

Data included in Tables I–IV indicate that soaking of seeds for 6 h decreased the quantity of available carboh-

Departments of Foods and Nutrition (S.J., U.M.) and Chemistry and Biochemistry (R.S.), Haryana Agricultural University, Hisar-125 004, India.

0021-8561/86/1434-0417$01.50/0

Table I. Mean ± SE of Total Soluble Sugar Contents (%) of Different Legumes[a]

treatment	legumes				
	Rajmah (red bean), 1	Bengal gram (chick pea), 2	red gram (pigeon pea), 3	black gram, 4	broad bean (horse bean), 5
raw	10.33 ± 0.06	8.95 ± 0.00	9.03 ± 0.13	9.81 ± 0.06	7.09 ± 0.13
			Soaking		
6-h soaking in plain water	8.39 ± 0.31 (−19)	7.69 ± 0.10 (−14)	9.00 ± 0.03 (0)	6.63 ± 0.13 (−32)	5.89 ± 0.16 (−17)
6-h soaking in $NaHCO_3$ soln	8.20 ± 0.29 (−21)	7.55 ± 0.03 (−16)	8.47 ± 0.03 (−6)	5.47 ± 0.03 (−44)	5.84 ± 0.09 (−18)
12-h soaking in plain water	7.19 ± 0.10 (−30)	7.08 ± 0.25 (−21)	8.37 ± 0.08 (−7)	5.38 ± 0.08 (−45)	5.66 ± 0.14 (−20)
12-h soaking in $NaHCO_3$ soln	7.08 ± 0.12 (−31)	7.00 ± 0.18 (−22)	8.32 ± 0.13 (−8)	5.28 ± 0.04 (−46)	5.58 ± 0.24 (−21)
			Soaking and Cooking		
6-h soaking in plain water and cooking for 60 min	3.16 ± 0.09 (−69)	3.53 ± 0.06 (−61)	5.60 ± 0.21 (−38)	2.63 ± 0.14 (−73)	3.63 ± 0.09 (−49)
6-h soaking in $NaHCO_3$ soln and cooking for 45 min	2.81 ± 0.10 (−73)	3.50 ± 0.06 (−61)	5.21 ± 0.12 (−42)	2.18 ± 0.02 (−78)	2.62 ± 0.12 (−63)
12-h soaking in plain water and cooking for 45 min	2.76 ± 0.61 (−73)	3.14 ± 0.10 (−65)	2.63 ± 0.03 (−71)	1.73 ± 0.01 (−82)	2.58 ± 0.11 (−64)
12-h soaking in $NaHCO_3$ soln and cooking for 30 min	2.69 ± 0.05 (−74)	3.03 ± 0.00 (−66)	1.83 ± 0.09 (−80)	1.50 ± 0.02 (−85)	2.45 ± 0.01 (−65)
			Soaking and Autoclaving		
12-h soaking in plain water and autoclaving at 15 psi for 30 min	2.59 ± 0.05 (−75)	2.56 ± 0.06 (−71)	1.73 ± 0.07 (−81)	1.48 ± 0.04 (−85)	2.41 ± 0.10 (−66)
12-h soaking in $NaHCO_3$ and autoclaving at 15 psi for 20 min	2.55 ± 0.04 (−75)	2.45 ± 0.05 (−73)	1.40 ± 0.06 (−84)	1.20 ± 0.01 (−88)	2.35 ± 0.01 (−67)
			Germination		
24 h	6.41 ± 0.09 (−38)	6.84 ± 0.17 (−24)	8.00 ± 0.12 (−11)	6.56 ± 0.08 (−33)	6.88 ± 0.22 (−3)
48 h	6.90 ± 0.09 (−33)	7.62 ± 0.08 (−15)	8.56 ± 0.24 (−5)	6.87 ± 0.09 (−30)	6.98 ± 0.41 (−2)
72 h	10.40 ± 0.04 (+1)	8.99 ± 0.10 (0)	9.15 ± 0.07 (+1)	10.56 ± 0.11 (+8)	7.82 ± 0.29 (+10)
96 h	10.60 ± 0.04 (+3)	9.25 ± 0.22 (+4)	9.32 ± 0.09 (+3)	10.72 ± 0.05 (+9)	7.94 ± 0.18 (+12)
24- germin and 10-min frying	4.59 ± 0.16 (−56)	6.06 ± 0.32 (−32)	6.72 ± 0.06 (−26)	5.94 ± 0.09 (−39)	5.69 ± 0.10 (−20)

[a] CD at 5%; pulses = 0.046; treatments 0.0824. Values in parentheses indicate the percent loss or gain under different treatments. Values given in the table are mean values of quadruple analyses.

Table II. Mean ± SE of Reducing Sugar Contents (%) of Different Legumes[a]

treatment	legumes				
	Rajmah (red bean)	Bengal gram (chick pea)	red gram (pigeon pea)	black gram	broad bean (horse bean)
raw	0.83 ± 0.01	0.57 ± 0.02	0.48 ± 0.01	0.21 ± 0.00	0.18 ± 0.00
			Soaking		
6-h soaking in plain water	0.47 ± 0.03 (−43)	0.47 ± 0.01 (−18)	0.39 ± 0.03 (−19)	0.19 ± 0.00 (−10)	0.16 ± 0.01 (−11)
6-h soaking in $NaHCO_3$ solution	0.35 ± 0.01 (−57)	0.30 ± 0.00 (−47)	0.36 ± 0.01 (−25)	0.13 ± 0.01 (−38)	0.11 ± 0.02 (−39)
12-h soaking in plain water	0.33 ± 0.01 (−60)	0.26 ± 0.02 (−54)	0.30 ± 0.02 (−38)	0.11 ± 0.00 (−48)	0.09 ± 0.01 (−50)
12-h soaking in $NaHCO_3$ soln	0.25 ± 0.01 (−70)	0.19 ± 0.03 (−67)	0.25 ± 0.00 (−48)	0.09 ± 0.00 (−57)	0.089 ± 0.00 (−51)
			Soaking and Cooking		
6-h soaking in plain water and cooking for 60 min	0.24 ± 0.00 (−71)	0.17 ± 0.01 (−70)	0.20 ± 0.00 (−58)	0.089 ± 0.00 (−58)	0.069 ± 0.00 (−62)
6-h soaking in $NaHCO_3$ soln and cooking for 45 min	0.22 ± 0.01 (−73)	0.14 ± 0.02 (−75)	0.16 ± 0.01 (−67)	0.084 ± 0.01 (−60)	0.065 ± 0.01 (−64)
12-h soaking in plain water and cooking for 45 min	0.17 ± 0.02 (−80)	0.10 ± 0.02 (−82)	0.095 ± 0.00 (−80)	0.07 ± 0.03 (−67)	0.045 ± 0.00 (−75)
12-h soaking in $NaHCO_3$ soln and cooking for 30 min	0.15 ± 0.02 (−82)	0.082 ± 0.01 (−86)	0.093 ± 0.03 (−81)	0.055 ± 0.01 (−74)	0.040 ± 0.00 (−78)
			Soaking and Autoclaving		
12-h soaking in plain water and autoclaving at 15 psi for 30 min	0.13 ± 0.01 (−84)	0.078 ± 0.01 (−86)	0.09 ± 0.01 (−81)	0.045 ± 0.02 (−79)	0.033 ± 0.01 (−82)
12-h soaking in $NaHCO_3$ soln and autoclaving at 15 psi for 20 min	0.099 ± 0.00 (−88)	0.069 ± 0.00 (−88)	0.079 ± 0.00 (−84)	0.035 ± 0.00 (−83)	0.025 ± 0.00 (−86)
			Germination		
24 h	0.35 ± 0.02 (−58)	0.24 ± 0.00 (−58)	0.40 ± 0.02 (−17)	0.19 ± 0.02 (−10)	0.16 ± 0.01 (−11)
48 h	0.50 ± 0.01 (−40)	0.39 ± 0.01 (−32)	0.38 ± 0.01 (−21)	0.60 ± 0.01 (+186)	0.59 ± 0.01 (+228)
72 h	0.89 ± 0.06 (+7)	0.61 ± 0.01 (+7)	0.67 ± 0.02 (+40)	1.32 ± 0.01 (+529)	0.68 ± 0.05 (278)
96 h	0.92 ± 0.01 (+11)	0.72 ± 0.01 (+26)	0.70 ± 0.01 (+46)	1.34 ± 0.03 (+536)	0.75 ± 0.03 (+317)
24-h germin and 10-min frying	0.32 ± 0.04 (−61)	0.23 ± 0.01 (−60)	0.35 ± 0.01 (−27)	0.15 ± 0.01 (−29)	0.099 ± 0.01 (−45)

[a] CD at 5%; pulses 0.0214; treatments 0.0382. Values in parentheses indicate the percent loss or gain under treatments. Values given in the table are mean values of quadruple analyses.

ydrates, total soluble sugars, reducing sugars, nonreducing sugars, and starch, significantly ($p < 0.05$). When the soaking time was increased to 12 h, the extent of decrase in all these carbohydrates was more pronounced in all the legumes. In sodium bicarbonate solution as soaking medium, the extent of loss was significantly ($p < 0.05$) higher than that observed when the seeds were soaked in plain water. The reduction in the levels of available carbohy-

Table III. Mean ± SE of Nonreducing Sugar Contents (%) of Different Legumes[a]

treatment	legumes				
	Rajmah (red bean)	Bengal gram (chick pea)	red gram (pigeon pea)	black gram	broad bean (horse bean)
raw	9.50 ± 0.05	7.38 ± 0.02	8.55 ± 0.12	9.60 ± 0.06	6.91 ± 0.13
			Soaking		
6-h soaking in plain water	7.92 ± 0.03 (−17)	7.30 ± 0.09 (−1)	8.53 ± 0.00 (0)	5.44 ± 0.12 (−43)	5.73 ± 0.09 (−17)
6-h soaking in $NaHCO_3$ soln	7.85 ± 0.28 (−18)	7.25 ± 0.03 (−2)	8.11 ± 0.02 (−5)	5.34 ± 0.02 (−44)	5.73 ± 0.09 (−17)
12-h soaking in plain water	6.53 ± 0.09 (−31)	6.82 ± 0.23 (−8)	8.07 ± 0.06 (−6)	5.27 ± 0.08 (−45)	4.56 ± 0.13 (−34)
12-h soaking in $NaHCO_3$ soln	6.45 ± 0.04 (−32)	6.31 ± 0.09 (−14)	7.25 ± 0.05 (−15)	4.40 ± 0.06 (−54)	3.16 ± 0.12 (−54)
			Soaking and Cooking		
6-h soaking in plain water and cooking for 60 min	2.92 ± 0.19 (−69)	3.36 ± 0.05 (−54)	5.40 ± 0.21 (−57)	2.54 ± 0.14 (−74)	2.56 ± 0.09 (−63)
6-h soaking in $NaHCO_3$ soln and cooking for 45 min	2.59 ± 0.09 (−73)	3.36 ± 0.04 (−54)	5.05 ± 0.11 (−41)	2.10 ± 0.01 (−78)	2.55 ± 0.11 (−63)
12-h soaking in plain water and cooking for 45 min	2.54 ± 0.05 (−73)	3.04 ± 0.10 (−59)	2.56 ± 0.03 (−70)	1.66 ± 0.01 (−83)	2.43 ± 0.11 (−65)
12-h soaking in $NaHCO_3$ soln and cooking for 30 min	2.54 ± 0.05 (−73)	2.91 ± 0.04 (−61)	1.74 ± 0.09 (−80)	1.45 ± 0.01 (−85)	2.41 ± 0.01 (−65)
			Soaking and Autoclaving		
12-h soaking in plain water and autoclaving at 15 psi for 30 min	2.46 ± 0.04 (−74)	2.48 ± 0.05 (−66)	1.64 ± 0.06 (−81)	1.44 ± 0.02 (−85)	2.38 ± 0.09 (−66)
12-h soaking in $NaHCO_3$ soln and autoclaving at 15 psi for 20 min	2.45 ± 0.04 (−74)	2.38 ± 0.05 (−68)	1.32 ± 0.06 (−85)	1.36 ± 0.01 (−86)	2.10 ± 0.09 (−70)
			Germination		
24 h	6.06 ± 0.08 (−36)	6.60 ± 0.17 (−11)	7.60 ± 0.11 (−11)	6.37 ± 0.08 (−34)	6.72 ± 0.20 (−3)
48 h	6.40 ± 0.08 (−33)	7.23 ± 0.08 (−2)	8.18 ± 0.23 (−4)	6.23 ± 0.08 (−35)	6.89 ± 0.40 (0)
72 h	9.51 ± 0.01 (0)	8.38 ± 0.09 (+14)	8.48 ± 0.06 (−1)	9.24 ± 0.10 (−4)	7.14 ± 0.29 (+3)
96 h	9.68 ± 0.03 (+2)	8.53 ± 0.21 (+16)	8.62 ± 0.08 (+1)	9.68 ± 0.05 (+1)	7.19 ± 0.15 (+4)
24-h germin and 10-min frying	4.27 ± 0.12 (−55)	5.83 ± 0.31 (−21)	6.37 ± 0.06 (−25)	5.75 ± 0.08 (−40)	5.59 ± 0.10 (−19)

[a] CD at 5%; pulses 0.0247; treatments 0.0442. Values in parentheses indicate the percent loss or gain under different treatments. Values given in the table are mean values of quadruple analyses.

Table IV. Mean ± SE of Starch Contents (%) of Different Legumes[a]

treatment	legumes				
	Rajmah (red bean)	Bengal gram (chick pea)	red gram (pigeon pea)	black gram	broad bean (horse bean)
raw	44.43 ± 0.69	47.45 ± 0.45	51.05 ± 0.45	52.83 ± 0.43	42.75 ± 2.26
			Soaking		
6-h soaking in plain water	44.33 ± 1.89 (0)	40.60 ± 0.37 (−14)	47.48 ± 1.18 (−7)	44.33 ± 0.93 (−16)	41.03 ± 1.70 (−4)
6-h soaking in $NaHCO_3$ soln	41.25 ± 0.58 (−7)	30.55 ± 0.98 (−36)	43.55 ± 0.26 (−15)	38.05 ± 0.94 (−28)	38.73 ± 1.13 (−9)
12-h soaking in plain water	36.88 ± 0.77 (−17)	27.93 ± 1.18 (−41)	38.93 ± 0.36 (−24)	36.93 ± 0.40 (−30)	33.10 ± 0.00 (−23)
12-h soaking in $NaHCO_3$ soln	35.83 ± 1.04 (−19)	23.10 ± 1.56 (−51)	34.65 ± 0.86 (−32)	30.27 ± 0.26 (−43)	30.33 ± 0.43 (−29)
			Soaking and Cooking		
6-h soaking in plain water and cooking for 60 min	31.50 ± 0.69 (−29)	20.73 ± 1.49 (−56)	27.68 ± 0.99 (−46)	27.88 ± 2.55 (−47)	24.53 ± 0.23 (−43)
6-h soaking in $NaHCO_3$ soln and cooking for 45 min	29.93 ± 0.68 (−33)	17.55 ± 1.54 (−63)	25.60 ± 1.81 (−50)	23.15 ± 0.90 (−56)	23.95 ± 0.58 (−44)
12-h soaking in plain water and cooking for 45 min	27.05 ± 0.45 (−39)	16.35 ± 1.68 (−66)	24.00 ± 2.24 (−53)	21.70 ± 0.00 (−59)	22.33 ± 0.18 (−48)
12-h soaking in $NaHCO_3$ soln and cooking for 30 min	23.50 ± 0.37 (−47)	14.95 ± 0.09 (−68)	26.60 ± 0.82 (−48)	19.95 ± 0.26 (−62)	20.00 ± 0.98 (−53)
			Soaking and Autoclaving		
12-h soaking in plain water and autoclaving at 15 psi for 30 min	19.40 ± 0.95 (−56)	12.20 ± 1.04 (−74)	20.63 ± 0.68 (−60)	14.23 ± 0.43 (−73)	19.35 ± 0.45 (−55)
12-h soaking in $NaHCO_3$ soln and autoclaving at 15 psi for 20 min	15.09 ± 0.78 (−66)	10.25 ± 0.00 (−78)	16.68 ± 0.23 (−67)	12.40 ± 0.40 (−76)	17.00 ± 0.37 (−60)
			Germination		
24 h	28.13 ± 0.68 (−37)	37.13 ± 1.99 (−22)	37.48 ± 1.30 (−27)	34.18 ± 0.60 (−35)	37.93 ± 0.68 (−11)
48 h	21.63 ± 1.70 (−51)	26.20 ± 0.64 (−45)	29.38 ± 0.43 (−42)	26.00 ± 0.64 (−51)	27.01 ± 0.72 (−37)
72 h	20.45 ± 1.81 (−54)	24.54 ± 0.04 (−48)	23.29 ± 0.11 (−54)	20.00 ± 0.80 (−62)	20.00 ± 0.18 (−53)
96 h	19.95 ± 0.80 (−55)	13.74 ± 0.74 (−71)	22.39 ± 0.10 (−56)	19.80 ± 0.70 (−63)	16.15 ± 0.15 (−62)
24 h germin and 10 min frying	20.61 ± 0.65 (−54)	34.44 ± 0.43 (−27)	35.78 ± 0.23 (−30)	31.01 ± 0.11 (−41)	32.08 ± 0.43 (−25)

[a] CD at 5%; pulses 0.3562; treatments 0.6373. Values in parentheses indicate the percent loss under different treatments. Values given in the table are mean values of quadruple analyses.

drates with these treatments occur mainly because of their solubility in plain water and sodium bicarbonate solution. This is a general phenomenon that has been observed earlier also in case of dry beans by Silva and Braga (1982).

The legume starch is composed of soluble and insoluble portions, and on soaking, the soluble portion might have been extracted out. When soaking in plain water or sodium bicarbonate solution was combined with cooking, the

extent of losses of four types of available carbohydrates from the legumes under study was significantly ($p < 0.05$) higher in comparison to that of simple soaking treatments. This is understandable again based on the fact that, in boiling water during cooking, the solubility of sugars will comparatively be much higher than at oridinary temperature. These results bear resemblance to those reported earlier by Iyengar and Kulkarni (1977) and Iyer et al. (1980). Contrary to these observations, Rao and Belavady (1978) reported that cooking brought about a significant increase in reducing and nonreducing sugars. These differences in the two cases could be explained mainly on the basis of the fact that, in studies of Rao and Belavady (1978), the cooked water was not discarded, whereas, in the present study and those of Iyengar and Kulkarni (1977) and Iyer et al. (1980), the soaking and cooking water was rejected and seeds alone after drying were analyzed for various carbohydrate components. When 12-h soaked seeds were autoclaved, the losses in available carbohydrates in each case were significantly ($p < 0.05$) higher than those of other treatments. On germination, total sugars, reducing sugars, and nonreducing sugars in each legume decreased during first 24 h of germination (Tables I–III). This is because during the first 24 h of germination, the sugars might have been utilized for the production of energy needed for various processes occurring in seeds. When the period of germination was prolonged, the content of reducing, nonreducing, and total sugars in each legume was significantly ($p < 0.05$) higher than that of control (raw legumes). In spite of this, we are still recommending 24-h germination as a reasonably good treatment for reduction of flatus-producing oligosaccharides. This is mainly because of the fact that even with 24 h of germination; raffinose, stachyose, and verbascose are lost to the extent of 13–70%, 35–75%, and 66–91%, respectively, in present pulses (Jood et al., 1985). These losses are good enough to avoid flatulence to a reasonably good extent, and at the same time, the house wife is not to keep waiting for cooking of the pulses. Moreover, on keeping for longer period for germination in homes, there is always a possibility for fungal contamination. This is why we have recommended 24-h germination as the most suitable treatment. The losses in starch content during germination in each legume increased with the stage of germination (Table II). There was increase in sugar content with the hydrolysis of starch. During germination, starch is mainly subjected to first slow degradation by phosphorylase and second rapid starch degradation with maximal activity of α-amylase (Sharma and Pant, 1979; Jaya and Venkataraman, 1980). When 24-h germinated seeds were fried, the concentrations of available carbohydrates further decreased significantly ($p < 0.05$) as compared to nonfried 24-h germinated seeds, indicating that frying also brings about solubilization of sugars in the frying medium.

ACKNOWLEDGMENT

We thank Dr. V. P. Singh for providing the samples of the legumes.

Registry No. $NaHCO_3$, 144-55-8; starch, 9005-25-8.

LITERATURE CITED

Aykroyd, W. R.; Doughty, J. In "Legumes in Human Nutrition"; Food and Agriculture Organization of the United Nations: Italy, 1977; pp 37–42.
Cerning, J.; Guilbot, J. *Cereal Chem.* **1973**, *50*, 220.
Clegg, K. M. *J. Sci. Food Agric.* **1956**, *7*, 40.
Iyengar, A. K.; Kulkarni, P. R. *J. Food Sci. Technol.* **1977**, *14*, 222.
Iyer, T. V.; Salunkhe, D. K.; Sathe, S. K.; Rockland, L. B. *Quality Plant* **1980**, *30*, 45.
Jaya, T. V.; Venkataraman, L. V. *Indian Food Packer* **1980**, *34*, 3.
Jood, S.; Mehta, U.; Singh, R.; Bhat, C. M. *J. Agric. Food Chem.* **1985**, *33*, 268.
Nelson, N. *J. Biol. Chem.* **1944**, *153*, 375.
Olson, A. C.; Becker, R.; Miers, J. C.; Gumbman, M. R.; Wagner, J. R. In "Protein Nutritional Quality of Foods and Feeds"; Friedman, M., Eds.; Marcel Dekker: New York, 1975; Part 2, p 551.
Rackis, J. J. In "Physiological Effects of Food Carbohydrates"; Jeans, A., Hodge, J., Eds.; American Chemical Society; Washington, DC, 1975; p 207.
Rao, P. U.; Belavady, B. *J. Agric. Food Chem.* **1978**, *26*, 316.
Reddy, N. R.; Salunkhe, D. K. *Cereal Chem.* **1980**, *57*, 356.
Reedy, N. R.; Salunkhe, D. K.; Sharma, R. P. *J. Food Sci.* **1980**, *45*, 1161.
Sharma, S. N.; Pant, R. C. *Indian J. Plant Physiol.* **1979**, *22*, 219.
Silva, H. C.; Braga, G. L. *J. Food Sci.* **1982**, *47*, 924.
Somogyi, M. *J. Biol. Chem.* **1945**, *160*, 61.
Yemm, E. W.; Willis, A. J. *Biochem. J.* **1954**, *57*, 508.

Received for review January 22, 1985. Revised manuscript received August 30, 1985. Accepted January 6, 1986.