AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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1. SUBJECT CLASSIFICATION

A. PRIMARY: Public Health

B. SECONDARY: Nutrition

2. TITLE AND SUBTITLE

Experimental production of atta

3. AUTHOR(S)

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4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1968	27 p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

Department of Grain Science and Industry, Kansas State University, Manhattan, Kansas 66502

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

(In Studies on attas and chapatis, I, pp. 101-128)

9. ABSTRACT

This paper describes a study designed to evaluate various methods of producing coarse flour (atta) and making unleavened bread (chapatis) from it, using several kinds of U.S. and Pakistani wheats. Chapatis made from atta is a common food in Pakistan and India. Attas of 80% and 95% extraction were prepared from Hard Red Winter, Hard Red Spring, Durum, White Club, Soft Red Winter, and Pakistani wheats. The particle size distribution of experimental attas were in the range of that of typical Pakistani attas. The composition and doughy characteristics of the experimental attas were experimentally varied. The chapatis made from the attas was evaluated in terms of its sight, aroma, and taste appeal by a panel of experienced chapatis-eaters, using a scoring system devised for the purpose. All attas except those produced from Durum wheat yielded satisfactory chapatis. Color is apparently a major factor in determining acceptability; the White Club and Pakistani wheat products were judged significantly more acceptable than those made from any red wheat.

10. CONTROL NUMBER

PN-AAB-872

11. PRICE OF DOCUMENT

12. DESCRIPTORS

Acceptability
Atta?
Flours
Nutritive values
Tests
Wheat

13. PROJECT NUMBER

14. CONTRACT NUMBER

CSD-1586 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

csd 1586

CSD-1586 Rec.
PN-AAB-87-

Studies on Attas and Chapatis I [1]

Experimental Production of Atta

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Summary

An experimental method was developed for making atta, the coarse flour from which unleavened bread (chapatis) is made in Pakistan and India. Attas of 80% and 95% extraction were prepared from Hard Red Winter, Hard Red Spring, Durum, White Club, Soft Red Winter and Pakistani wheats. Particle size distribution of experimental attas were in the range of that of typical Pakistani attas. Proximate composition and dough characteristics of the experimental attas were determined. A standard method was developed and used to produce chapatis from the experimental attas. The chapatis were evaluated organoleptically by a panel using a scoring system devised for the purpose. All attas except those from Durum wheat yielded satisfactory chapatis. Color apparently is a major factor in determining acceptability; the White

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2/ This paper is based in part on the dissertation presented by M. Shafiq Chaudhry in partial fulfillment of the requirements for the Ph.D. degree. Dr. Chaudhry's present address is Department of Food Science, West Pakistan Agricultural University, Lyallpur, Pakistan.

Club and Pakistani wheat products were found to be significantly more acceptable than those from any red wheat.

Introduction

Unleavened bread is a staple article of food in Pakistan and India. It is similar in appearance to a tortilla but made of coarse wheat flour and known as a "chapati". The flour from which chapatis are made is called "atta". The typical chapati is prepared from atta and water mixed into a dough that is cooked on a flat, ungreased, hot surface. The chapati is turned several times during cooking and finally, if of good quality, it puffs, i.e., the two surfaces separate because of considerable expansion of gases, probably mostly steam, between them. The puffing subsides as the chapati cools, so the cooked chapati resembles a light tan tortilla flecked with dark brown spots. When cold, a cooked chapati is soft and pliable.

There currently is much interest in possible improvement of average diets in both Pakistan and India. As chapatis are the staple food and sometimes practically the only food in large parts of both countries, improved nutrition must depend primarily on improvement of the nutritive value of chapatis. Particle size of conventional wheat flour of Europe and the Americas is, however, usually considered too small for good chapatis. There is very little in the literature on the production and characteristics of atta. Yet it is obviously very difficult to study nutritional improvement of a product unless the raw material is either readily available or can easily be produced.

Materials and Methods

Seven samples of wheat were used for the study. Each was fumigated when received.

Hard Red Winter: One sample, Triumph variety, from a farm near Scott City, Kansas.

Hard Red Spring: One sample, Selkirk variety from Minnesota.

Durum: One commercial blend from Peavey Mills, Minneapolis.

White Club: Two samples, Burt and Gaines varieties, respectively, grown in the state of Washington.

Soft Red Winter: One composite sample already on hand.

Pakistani: One blend of improved varieties C-273 and C-228 from the Department of Plant Breeding and Genetics, West Pakistan Agricultural University, Lyallpur.

Five hundred grams of each sample was milled and the resulting atta tested for making chapatis. (Wichita variety, (Hard Red Winter) a commercial blend of Hard Red Spring and Omar variety, (White Club) also were used in preliminary tests and found to be not appreciably different from other samples in their respective classes.)

A milling method was developed that yielded attas closely approximating in properties samples obtained from Pakistan. A Hart-Carter Dockage Tester was used for cleaning, with all settings as recommended by the manufacturer. Each sample was conditioned to 15% moisture conten by adding the calculated amount of water as a spray to the grain as it was tumbled in a small rotating drum. The conditioned wheat was held in polyethylene bags 24-48 hours before milling. The milling flow sheet is shown in Fig. 1. Ross experimental roller mills were used.

All except the smooth pair of rolls were of "Getchell" type, set dull to dull. The sifting was carried out on a Smico laboratory sifter for 2 min., except in the fourth step where the time was 15-30 sec., depending on the wheat being milled, to obtain approximately 5% overs of 44 W.

Two types of atta, 95% and 80% extraction, were obtained. For 95% extraction, 5% bran (overs of 44 W from the fourth grind) was removed. For 80% extraction, 15% fines (thrus of 10XX) was also removed. After appropriate removal the remaining millstreams were pooled and blended 25 min. in a laboratory blender.

Eleven samples of atta that represented products made (a) on steel roller mill (A-E), (b) on the manually operated stone grinder locally known as a "chakki" in Pakistan (F-H), and (c) on animal-powered stone burr mills (I-K) were employed to determine the particle size distribution of acceptable attas. (Letters refer to designations in Fig. 3.) Two hundred grams of atta were sifted for 2 min. on a Rotap sifter through sieves indicated in Fig. 1. The overs of each sieve and thrus of 150 W were used to calculate a cumulative particle size curve.

Analyses for moisture, crude protein, ash, crude fat and crude fiber were made according to methods 44-15, 46-10, 08-10, 30-20, and 32-15, respectively, in Cereal Laboratory Methods (1962).

Preliminary studies were made of doughs prepared by housewives from Pakistan and India. The amounts of water used by three housewives with 300 grams of atta of 95% extraction (from Gaines variety wheat) were 49%, 59%, and 71.5%, respectively. A small amount of vegetable oil was added when 49% water was used. Each dough was immediately

placed in a large size farinograph bowl and the consistency determined. The values were 1,000 B.U., 780 B.U. and 410 B.U., respectively. All gave acceptable chapatis.

A mechanical procedure to evaluate doughs, for chapatis was devised on the basis of knowledge obtained of machinery used for making tortillas. Two sets of sheeting rolls were adapted to determine machinability. The first set, a product of National Machinery Co., had a roll speed of 85 r.p.m., peripheral speed 84 ft. per min., this set was adjusted to a clearance of one-eighth inch between the rolls. The second set, a product of Anetsburger Bros., Inc., had a roll speed of 60 r.p.m., peripheral speed 52 ft. per min., adjustment was made to a clearance of 0.050 in. between the rolls. Attas were evaluated for machinability by starting at 71% absorption and decreasing absorption by 1% at each trial until a dough was obtained that made a clean pass through each set of rolls. Wrinkling after the second rolls could be reduced by (a) substituting 2% water with an equal amount of vegetable oil (Wesson oil), (b) reducing absorption by 5% from the level that gave no sticking to the rolls, (c) generous use of dusting flour (atta). Combining the three factors completely eliminated wrinkling and improved the handling properties of the chapatis. In Pakistan and India, the housewife commonly uses over 70% absorption and employs dusting flour (atta) to improve handling properties. Fat is sometimes used in making chapatis in India; the product is then not a chapati but a "paratha". Economic considerations often prohibit the use of butter fat or processed vegetable oils in India and Pakistan.

Procedures 54-21 and 54-10 in Cereal Laboratory Methods (1962) were used to evaluate dough characteristics in the farinograph and extensiograph, respectively.

Cooked chapatis were evaluated organoleptically by a panel of judges composed of seven students from Pakistan and India to whom chapatis were a common and well-known food. A scoring system was devised by which each characteristic was evaluated on a scale from 0 to 10, a score of 0 representing the poorest quality and 10 the best (Fig. 2). Each chapati was prepared from 50 gm. of atta, sheeted, cooked on a hot plate, cooled for about 5 minutes and wrapped in wax paper until it was presented to the judges. Organoleptic data were analyzed by students "t" distribution test and analysis of variance (Alder and Roessler 1958).

Results and Discussion

The particle size distribution of attas obtained from Pakistan varied considerably (Fig. 3); that of sample A, from a modern mill, was considered to represent what would probably be available for large-scale production of chapatis, similar to production of bread in a commercial bakery.

The method developed for milling wheat to atta gave products with particle size distribution well within the limits of distribution found for Pakistani attas (Figs. 4, 5, 6), although there were large variations among both the commercial and the experimentally milled samples. Attas of 95% extraction from Pakistani and Hard Red Spring wheats were similar in particle size distribution. However, Aziz and Bhatti (1962) found a

wide range in the granularity of attas from various sources, yet all made good chapatis. Probably color is more important than granularity, within a wide range, in determining quality of atta.

Proximate composition of the attas is shown in Table I. Protein content was from 11.65% to 15.42%, ether extract was from 1.40% to 2.02%, and ash content was from 1.38% to 1.81%. Hard Red Winter wheat most nearly approached Pakistani wheat in the protein content of the atta, whereas the hard wheats gave attas of appreciably higher ash content than that of atta from Pakistani wheat.

No conditions were found that permitted preparation of a machinable dough from Durum wheat atta. Attas of the other wheats were machinable when water was added at 5% below maximum absorption, 2% of the water was replaced with vegetable oil, and generous use was made of dusting flour.

Farinograph curves (titration to 500 B.U.) are shown in Figs. 7 and 8. Extensiograph curves are shown in Figs. 9 and 10. Neither showed differences that could be related to differences in quality of chapatis made from attas.

Rate of extraction of the atta had no significant effect on acceptability of chapatis except in the case of Gaines wheat, where the atta of 95% extraction was judged to yield a slightly better chapati than the atta of 80% extraction (Table II).

When chapatis from attas of 95% extraction were compared, those from Burt, Gaines and Pakistani wheats were significantly better than the others, chiefly on the basis of color, but with a slight influence from flavor differences (Table III).

A similar trend was noted when chapatis from attas of 80% extraction were compared. In this series, flavor played a more pronounced role in the differences. The judges may have been more influenced by color than they realized, as the tests were carried out under ordinary fluorescent lighting. The tests may not have shown actual differences in flavor, but simulated the usual conditions of consumption closely enough to give good indication of consumer preference.

The results explain why U.S. wheats are often judged inferior for making atta. If only White Club wheats were supplied to atta producers, the quality of U.S. wheats might well be judged excellent.

Alder, H. L., and Roessler, E. B., 1958. Statistical Procedures. 2nd ed. Mimeographed, University of California, Davis.

American Association of Cereal Chemists Cereal Laboratory Methods, 7th ed. The Association, St. Paul, Minnesota. 1962.

Aziz, M. A., and Bhatti, H. M., 1962. Quality considerations for chapatis (unleavened pancakes). Agriculture, Pakistan 13 (1), 157-164.

The authors are grateful to the Western Wheat Quality Laboratory for supplying the White Club wheats and to those who furnished the other samples; to the Ganesh Flour Mills, Lyallpur, Pakistan, for a sample of atta; to the members of the judging panel. The senior author appreciates the support of himself by A.I.D. during the study and the facilities, equipment and supplies furnished by Kansas State University.

TABLE I

Chemical analysis of atta samples milled from indicated wheats*

Atta	Extraction rate	Moisture (%)	Crude protein (%)	Crude fat (%)	Ash (%)
Hard Red Winter	80%	12.95	14.56	1.66	1.72
Hard Red Winter	95%	13.03	15.04	1.47	1.60
Hard Red Spring	80%	13.43	13.69	2.02	1.76
Hard Red Spring	95%	13.21	14.11	1.85	1.61
Soft Red Winter	80%	13.35	12.92	1.85	1.81
Soft Red Winter	95%	13.35	12.46	1.70	1.62
Burt	80%	13.30	11.65	1.59	1.44
Burt	95%	13.02	12.02	1.40	1.38
Gaines	80%	13.28	12.45	1.76	1.64
Gaines	95%	12.79	12.04	1.42	1.55
Pakistani	95%	12.45	15.42	1.59	1.44

* Crude protein, crude fat, and ash are expressed on moisture free basis

TABLE II

Effect of the rate of extraction on the organoleptic properties of chapatis prepared from attas of 80% and 95% extraction of indicated wheats.

Type of wheat	Rate of extraction, %	Average score of seven panel members			
		Color	Flavor	Texture	Acceptability
Hard Red Winter	80	7.00	7.57	7.71	8.00
		n.s	n.s	n.s	n.s
	95	7.29	7.43	7.29	8.00
Hard Red Spring	80	6.86	7.29	7.43	7.43
		n.s	n.s	n.s	n.s
	95	7.14	7.43	7.29	7.21
Soft Red Winter	80	6.86	7.00	7.14	7.14
		n.s	n.s	n.s	n.s
	95	7.71	7.43	7.57	7.57
Burt Wheat	80	9.93	8.79	8.57	9.36
		n.s	n.s	n.s	n.s
	95	9.79	8.43	8.57	9.07
Gaines Wheat	80	9.14	8.86	8.64	8.93
		n.s	n.s	n.s	*
	95	9.57	9.00	8.71	9.36

*. significant at 0.05 level

n.s nonsignificant

TABLE III

Analyses of variance for color, flavor, texture and acceptability of chapatis prepared from attas of 95% extraction of different wheats.

Source of variance	Degrees of freedom	Mean square and significance			
		Color	Flavor	Texture	Acceptability
Wheat	5	22.768**	3.820*	2.114 n.s.	7.394**
Error	36	0.710	1.483	1.609	0.831
Total	41				

n.s. nonsignificant

* significant at 0.05 level

** significant at 0.01 level

TABLE IV

Analyses of variance for color, flavor, texture and acceptability of chapatis prepared from attas of 80% extraction of different wheats.

Source of variation	Degrees of freedom	Mean square and significance			
		Color	Flavor	Texture	Acceptability
Wheat type	5	23.84**	8.148**	2.024 n.s.	13.924**
Error	36	0.78	1.286	2.175	0.944
Total	41				

n.s. nonsignificant

** significant at 0.01 level

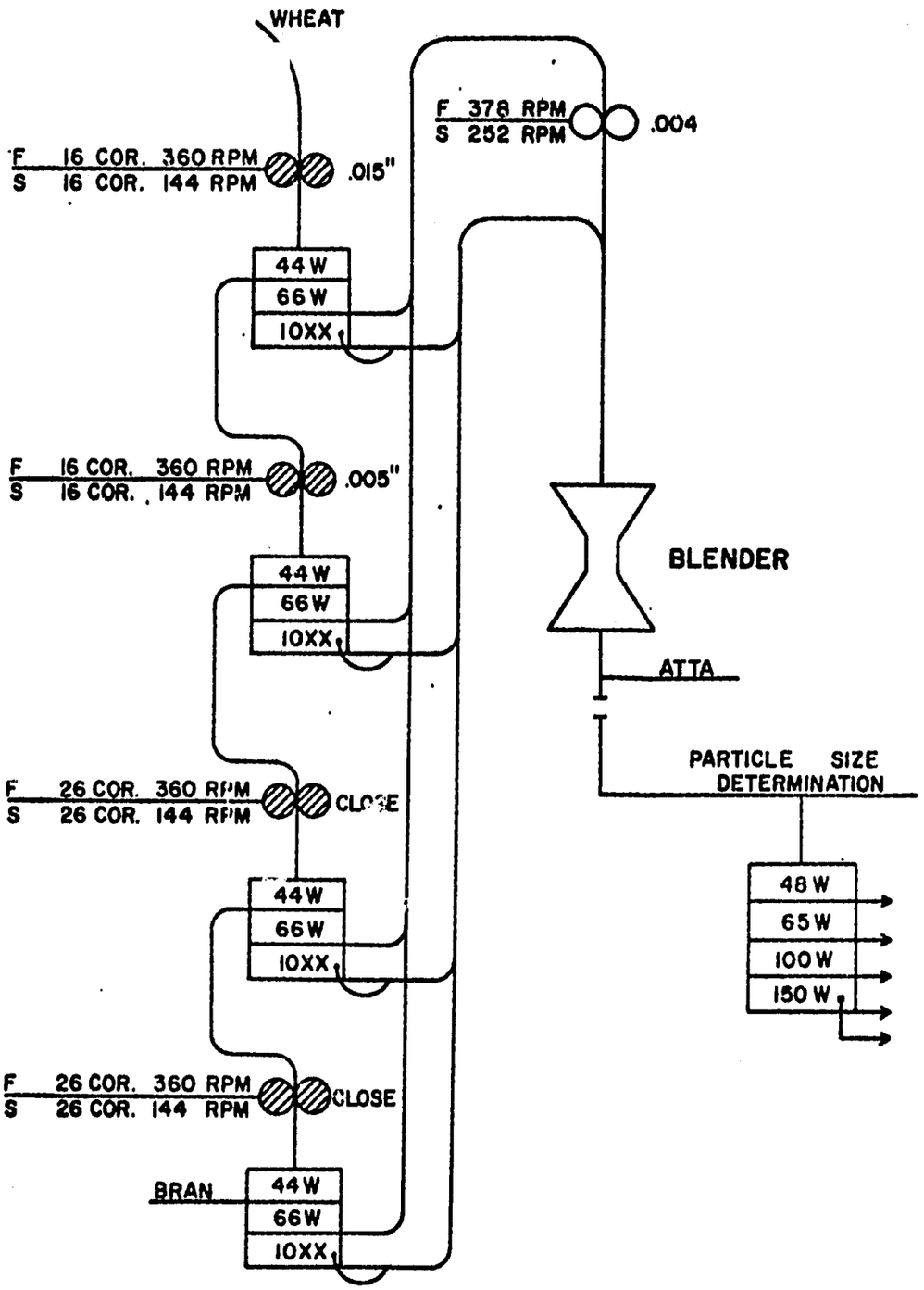

Figure 1. A schematic flow sheet for milling of atta from wheat and set of Tyler sieves used in particle size determination.

FIGURE 2

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Score Sheet for Chapatis

Name_____ Date_____

Please examine the Chapatis samples and score these with respect to the qualities in question, using the following scale:

Best_____10 points

Poorest_____ 0 points

Quality in question	Score
1. Color	
2. Flavor	
3. Texture	
4. Acceptability	

Suggestions or Comments:

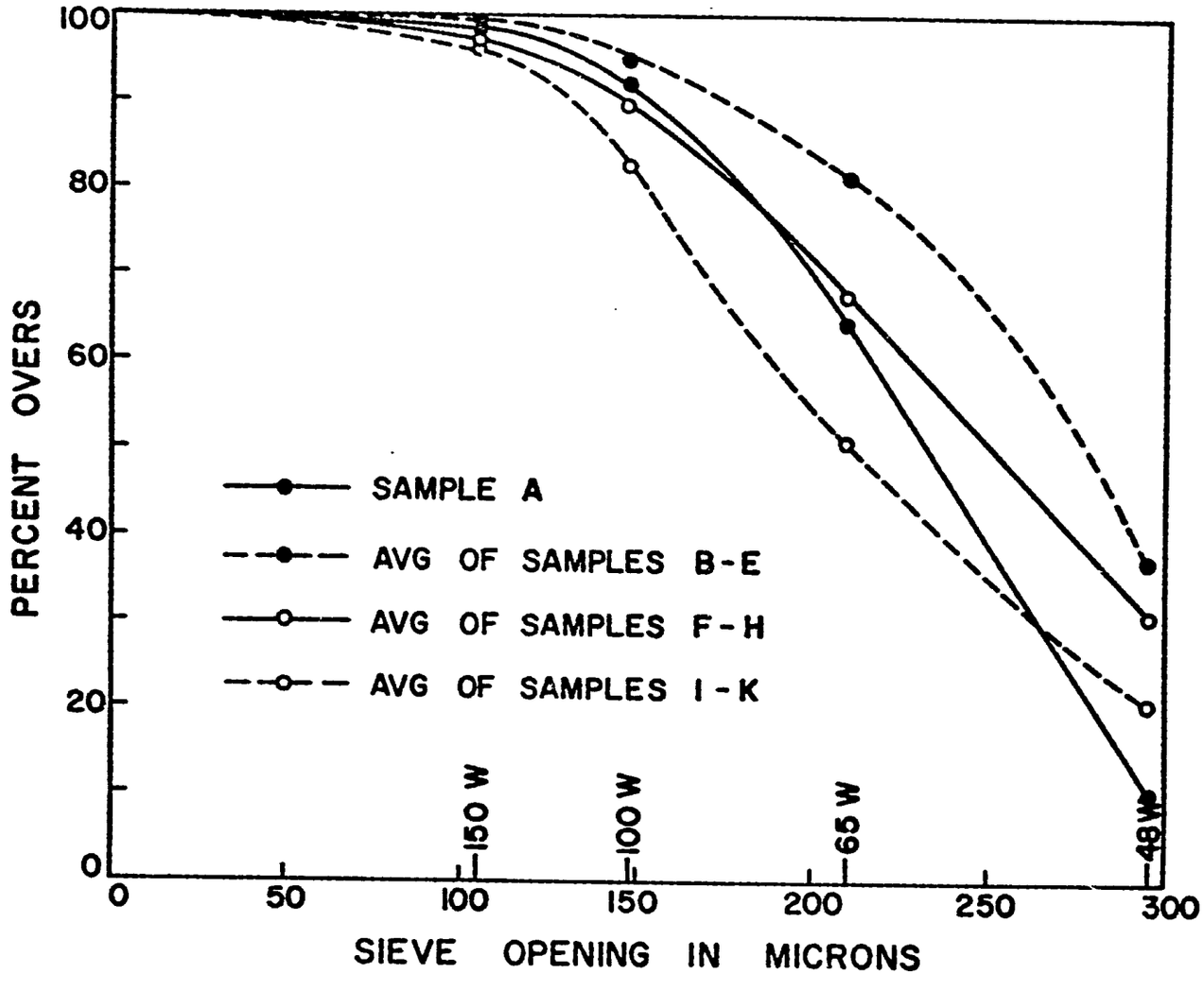


Figure 3. Cumulative particle size distribution curves of atta samples imported from Pakistan.

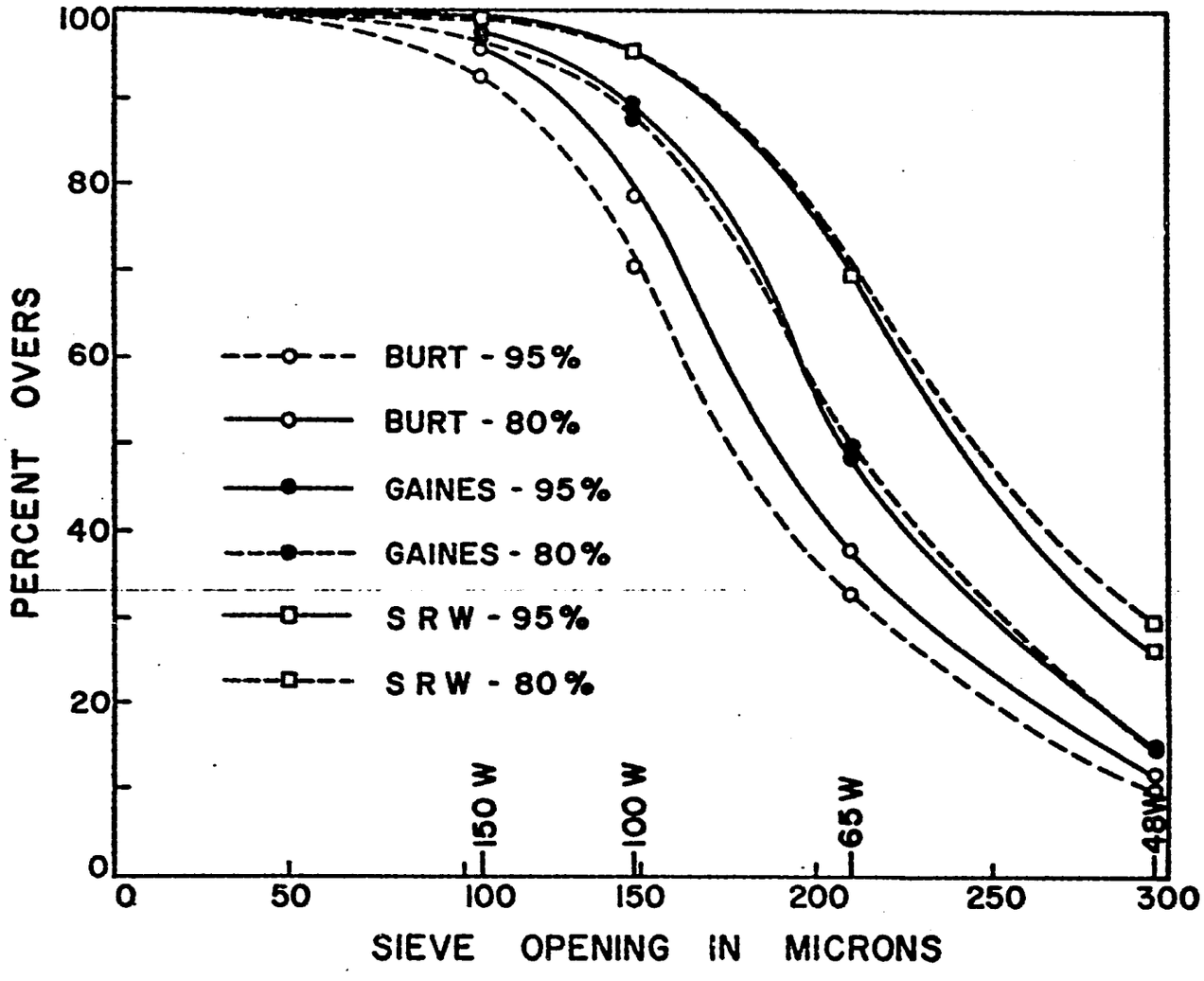


Figure 4. Cumulative particle size distribution curves of attas milled from Burt, Gaines and Soft Red Winter wheats.

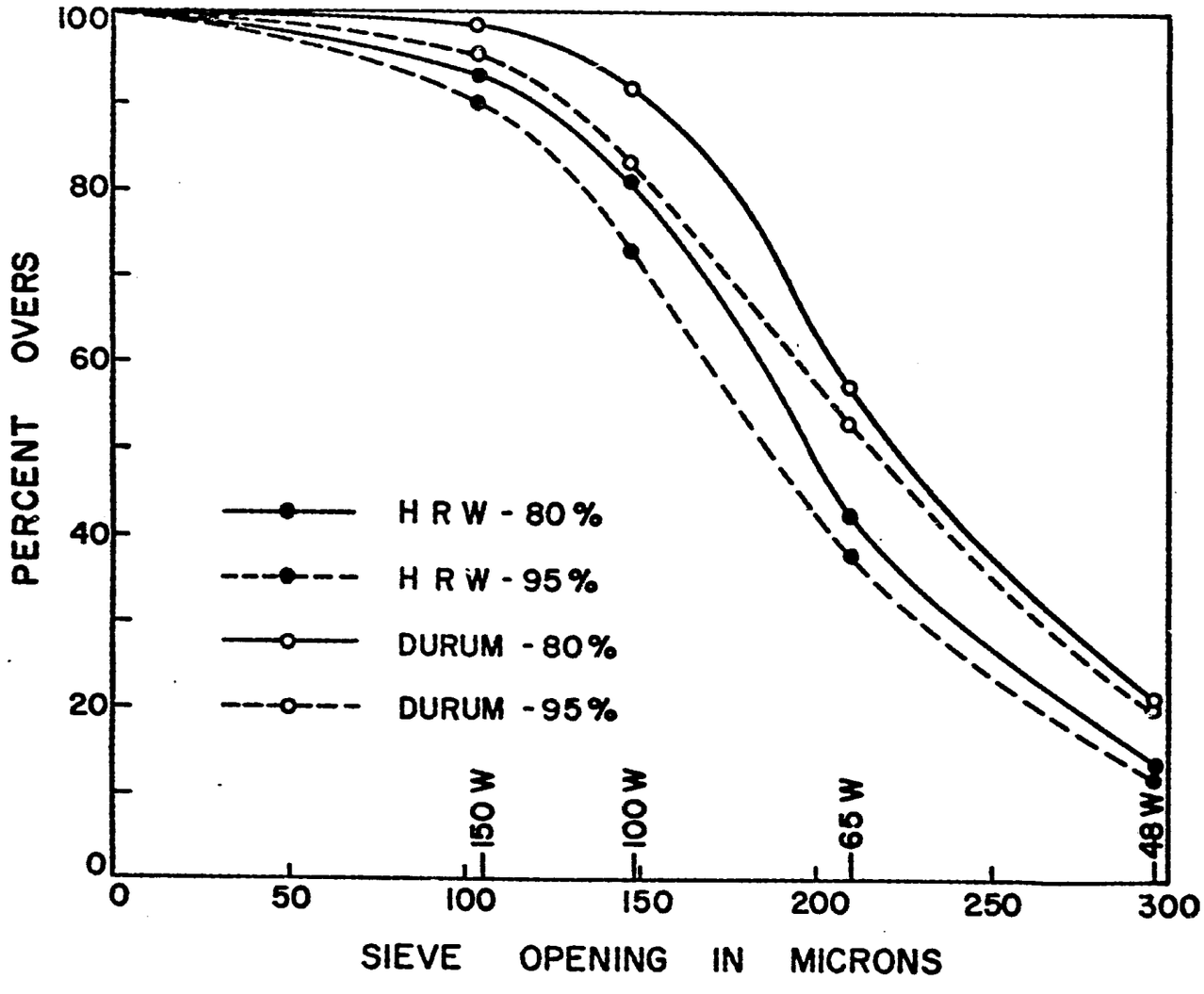


Figure 5. Cumulative particle size distribution curves of attas milled from Hard Red Winter and Durum wheats.

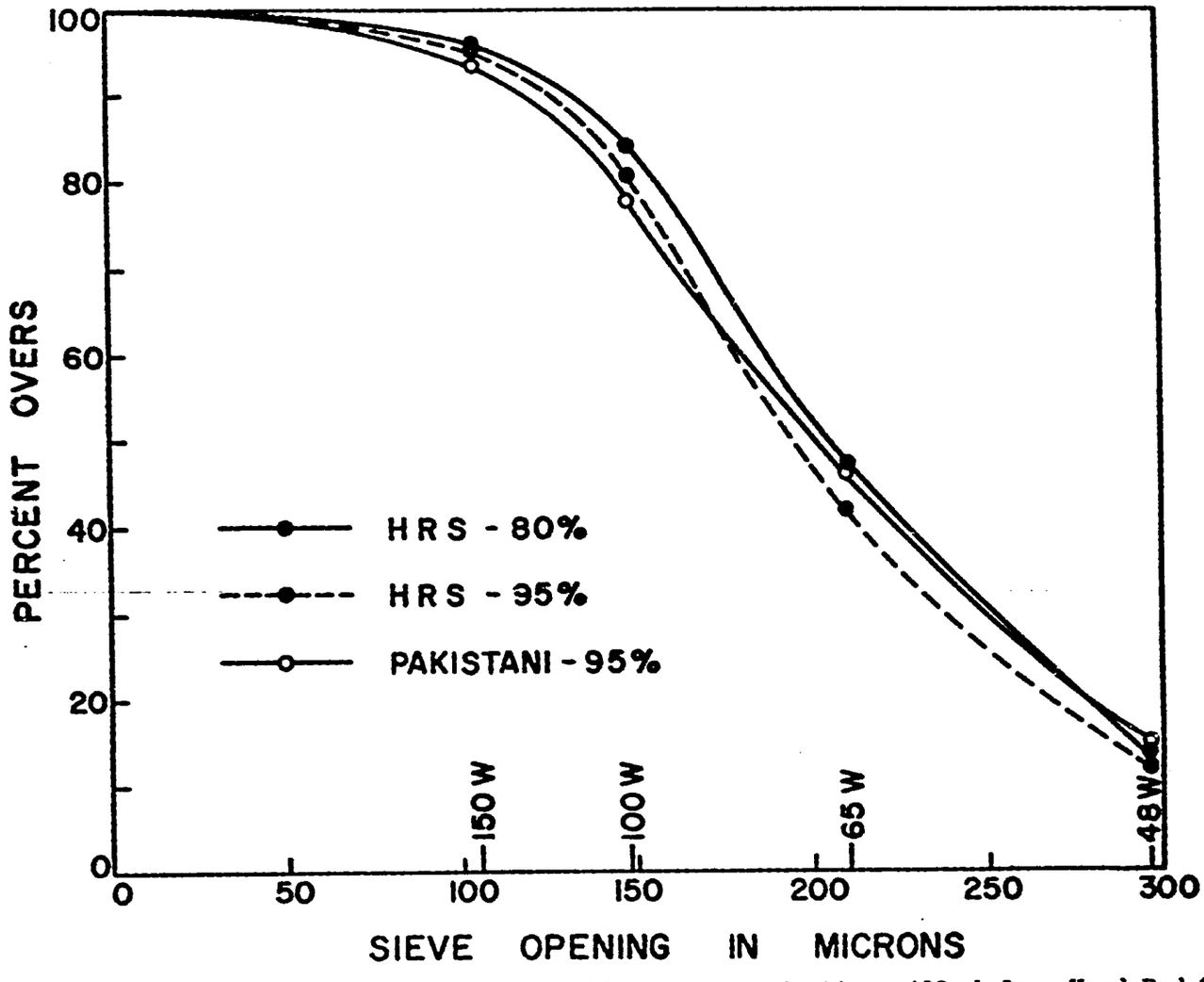


Figure 6. Cumulative particle size distribution curves of attas milled from Hard Red Spring and Pakistani wheats.

Figure 7. Farinograph curves of attas from Gaines, Burt, and HRS Wheats

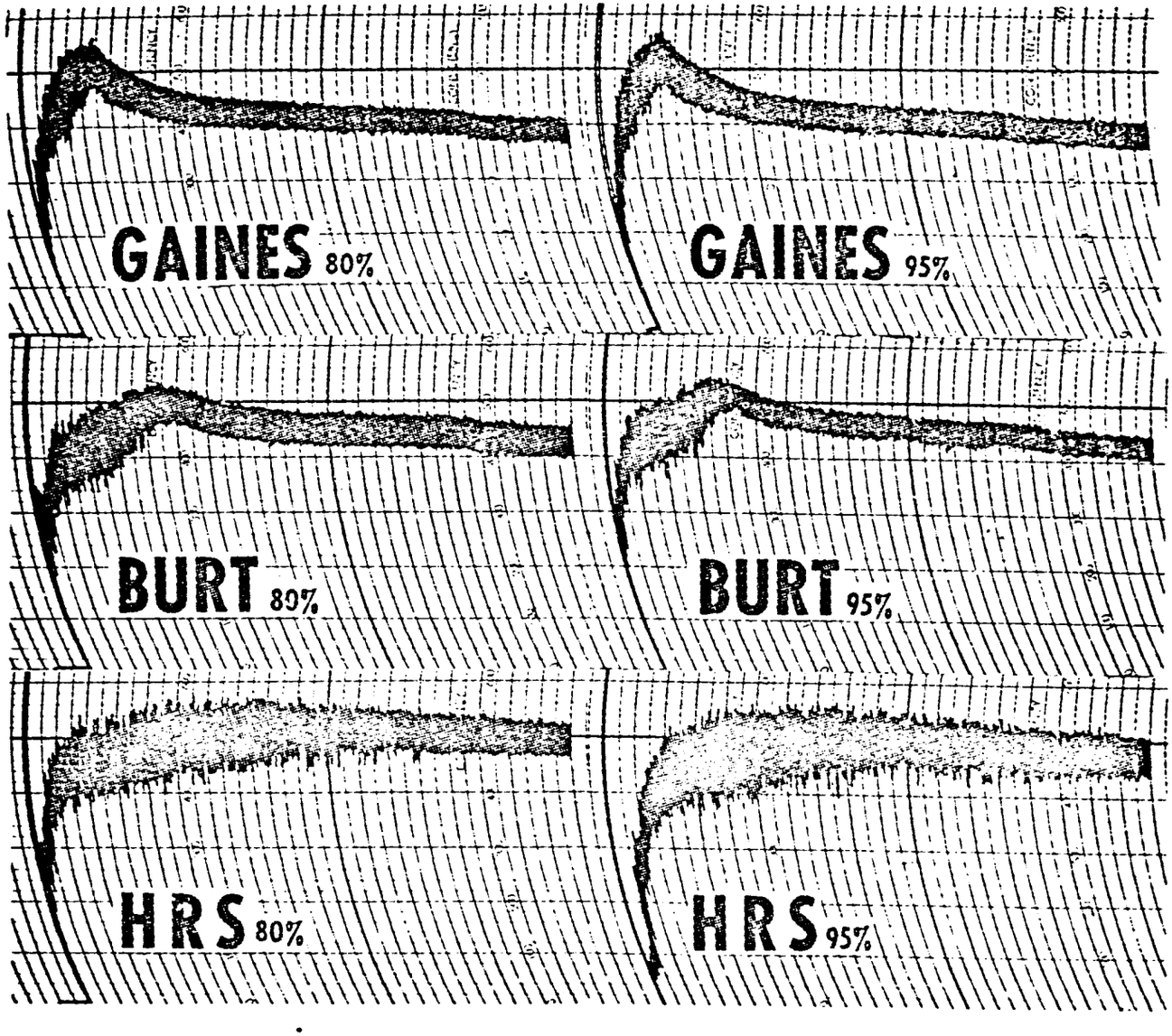

GAINES 80%
GAINES 95%
BURT 80%
BURT 95%
HRS 80%
HRS 95%

Figure 8. Farinograph curves of attas from SRW, HRW and C 273 Wheats

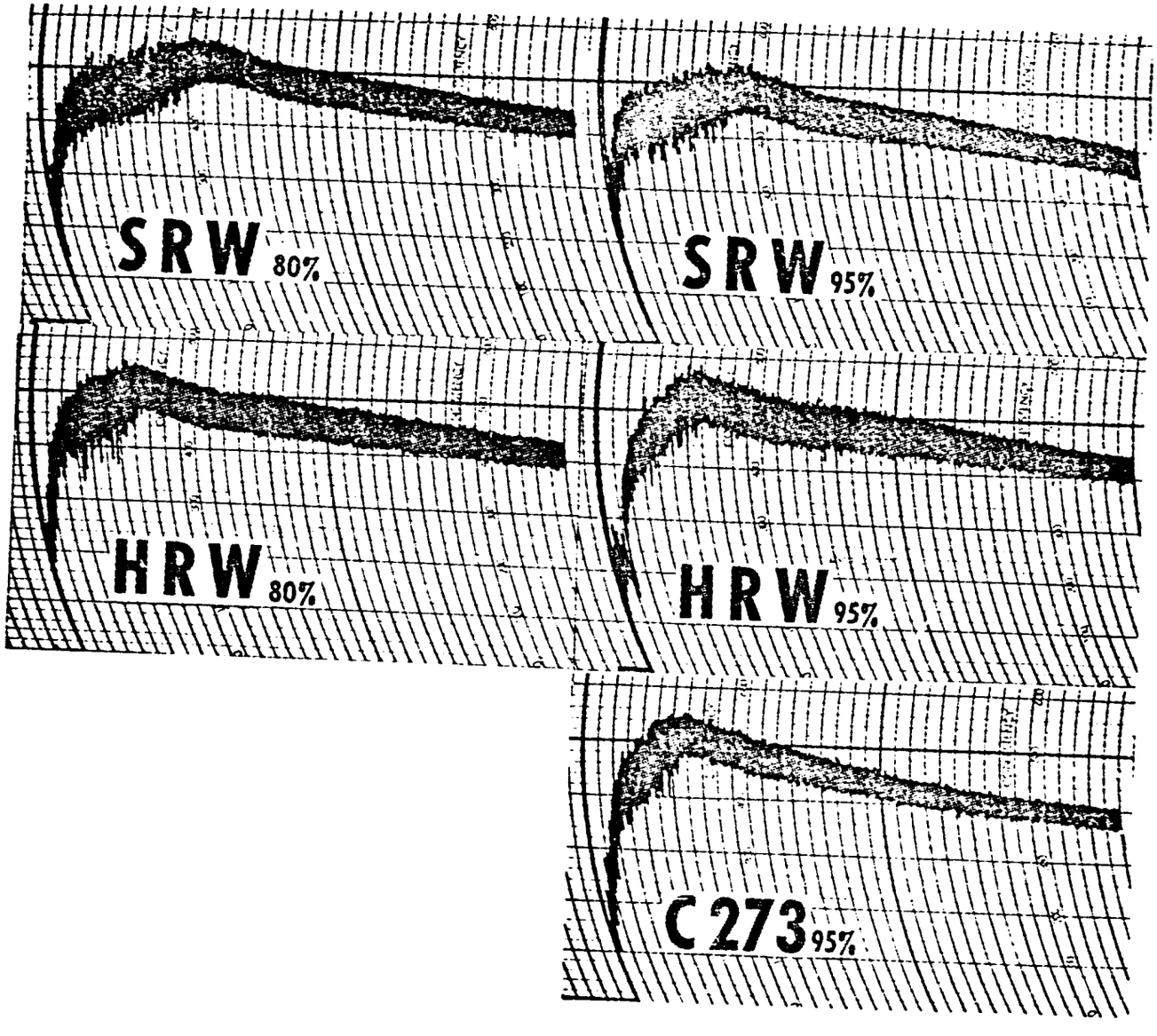

SRW 80%
SRW 95%
HRW 80%
HRW 95%
C 273 95%

Figure 9. Extensiograph curves of attas from Gaines, Burt, and HRS Wheats

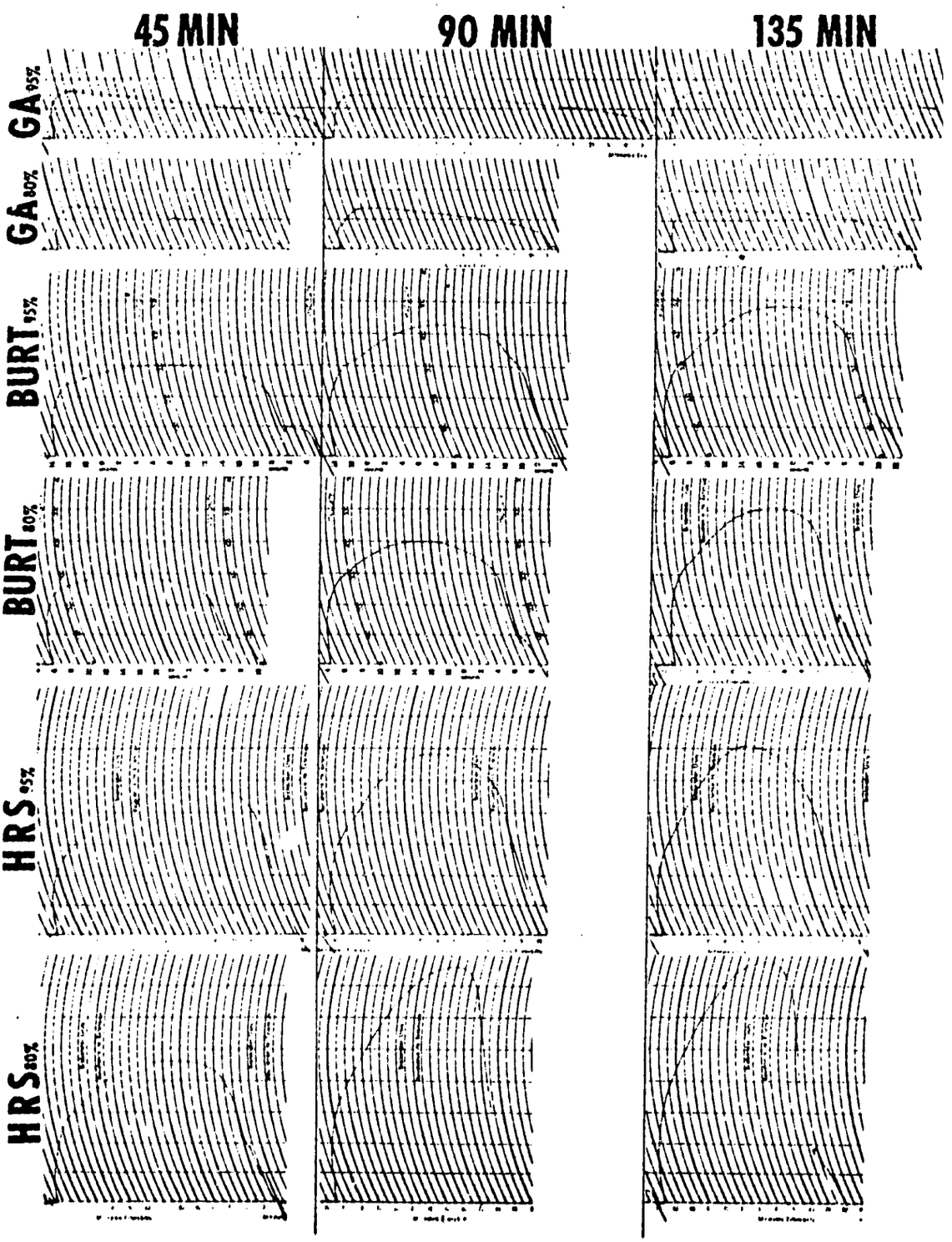
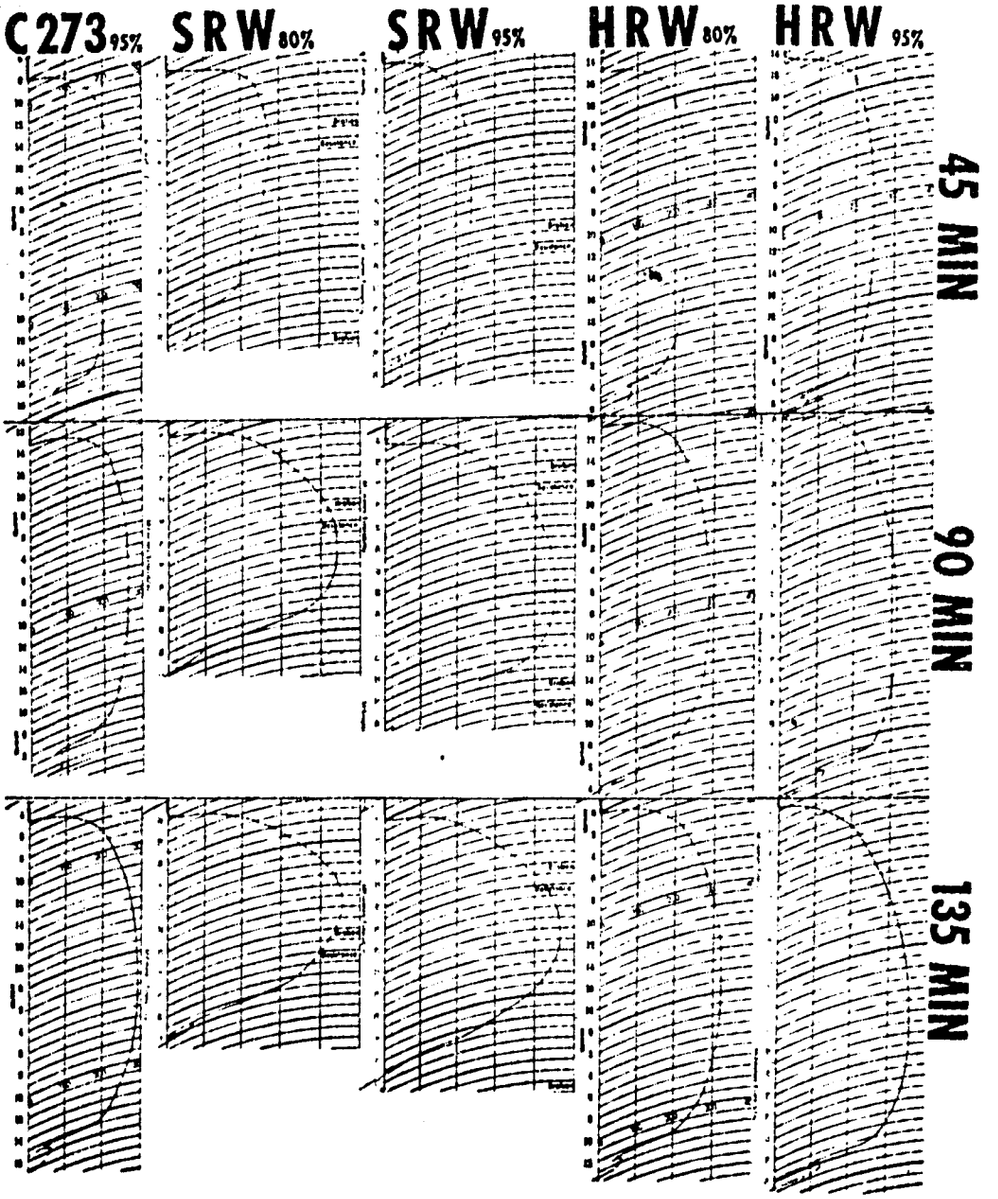

45 MIN
90 MIN
135 MIN
GA95%
GA80%
BURT95%
BURT80%
HRS95%
HRS80%

Figure 10. Extensiograph curves of attas from HRW, SRW, and C 273 Wheats


C273 95%
SRW 80%
SRW 95%
HRW 80%
HRW 95%
45 MIN
90 MIN
135 MIN