THE MACARONI COOKING QUALITY OF NORTH DAKOTA DURUM WHEAT

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Although information on the milling and macaroni processing quality of North Dakota durum wheat varieties has been published (4) their macaroni cooking value has not been stressed. Cooking quality is important because it is concerned with consumer acceptance of a new variety. It is the finished macaroni product that the consumer comes into contact with and on which the eating value of the product is judged. The production of durum varieties unsatisfactory in cooking properties can only lead to decreased sales of macaroni products, particularly "long goods" such as macaroni and spaghetti where quality is especially important.

Briefly, the three chief factors concerned in the determination of cooking quality are water absorption during cooking, measured by the gain in weight of the cooked material; the amount of disintegration of the macaroni during cooking, as determined by the quantity of substance removed by the cooking water, and the tenderness of the cooked product. The cooking is done under standard uniform conditions, such as length of time, temperature, and number and method of stirrings.

EXPERIMENTAL

The durums described in this investigation are 4 new varieties which have resistance to the 15-B stem rust complex, and Mindum and Sentry which are quite satisfactory for quality when not attacked by stem rust. The milling and processing properties of these have been discussed in the North Dakota Station Bimonthly Bulletin No. 19, 1957. The wheats were grown only at Langdon in 1954, at 5 stations in 1955, Williston being omitted, and at 6 stations in 1956 and 1957.

Four unnamed durum hybrids grown in plots for the first time, in 1957 at Langdon and Fargo only, are also included in this report. These are now being evaluated for quality and have not been reported on before.

This paper summarizes the cooking quality of a number of new durum varieties in comparison with Sentry and Mindum, which are two standard accepted varieties.

The determination of cooking quality was made as described in the literature (1) and was essentially as outlined here.

Twenty-five grams of dry macaroni were used for the cooking test. This was placed in tall form 500 ml. beakers containing 250 ml. of distilled water at 95.5°C. The temperature of the water in the beakers was maintained by the use of a constant temperature bath held at 101° C. The macaroni was cooked for 30 minutes, with two gentle stirrings during this period. The cooked macaroni was then drained on a Buchner fun-

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Fig. 1. Cooking, with stirring, of macaroni samples.

Fig. 2. Determination of the tenderness of cooked macaroni. The progress of breakdown of the macaroni piece is traced automatically on the paper in front of operator.

nel, washed thoroughly with distilled water and the drainings and washings evaporated to dryness and the weight determined. The residual macaroni was also weighed and reported as cooked weight.

Five representative strands of the cooked material were used for the evaluation of tenderness, yielding 5 replicates of the tenderness value. The technique and apparatus employed in this test have been described in detail (2). Figure 1 shows the cooking bath with stirring of the macaroni. Figure 2 shows the tester which measures the weight required to collapse the tube of cooked macaroni.

RESULTS AND DISCUSSION

Table 1 shows the mean results for the 6 durum varieties grown for 4 years. Each mean represents an average of 18 separate determinations, and the data present a reliable picture of the important quality properties of these wheats. Figure 3 shows the cooked weight, and Fig. 4 the tenderness scores, providing a direct comparison between results obtained from the different varieties. The table shows that Sentry and Yuma were the highest in protein content, while Langdon, Ramsey and Towner were approximately the same. Mindum was the lowest by nearly 1 percent. However, all the varieties were well within a satisfactory range of wheat protein content.

For the macaroni color score Sentry and Langdon were the best, while Ramsey and Mindum were lower, but still very good. Their scores corresponded well with the average for the 6 wheats. Yuma was lower, but would be rated satisfactory. Towner had the poorest color score and would be classed as having the lowest acceptable color rating. Towner has been accepted by the industry for macaroni and spaghetti production.

Dough mixing properties varied considerably for the 6 varieties, as revealed by the data in the third column of Table 1. Yuma had the strongest pattern and was quite different from the remaining 5, being a little too strong. Mindum was lower in mixing properties and was very satisfactory. The 4 other varieties were satisfactory, except for Sentry which was a trifle weak. The importance of mixing patterns is not as marked in durums as in hard red spring bread wheats but it seems that, other factors being equal, the variety with an average mixing pat-

TABLE 1. Variety Means for Wheat Protein Content, Macaroni Color Score, Mixing Properties and Cooking Quality Arranged in Order of Decreasing Macaroni Color Score.

Varieties	Wheat protein content[1]	Visual color score of macaroni	Mixing pattern	Residue[1]	Cooked weight[1]	Tenderness score
	%			gms.	gms.	
Sentry	14.9	9.1	Very weak (2.0)	1.07	89.1	177.3
Langdon	14.3	9.1	Weak (3.2)	1.09	83.6	168.6
Ramsey	14.2	8.4	Weak (3.4)	1.06	86.9	155.4
Mindum	13.4	8.3	Medium (5.2)	1.06	86.9	162.4
Yuma	15.1	8.1	Strong (6.9)	1.03	82.9	195.8
Towner	14.3	7.5	Med. Weak (3.7)	1.04	84.4	156.2
Average	14.4	8.4	Med. Weak (4.1)	1.06	85.6	169.3

[1]Expressed on 13.5% moisture basis.

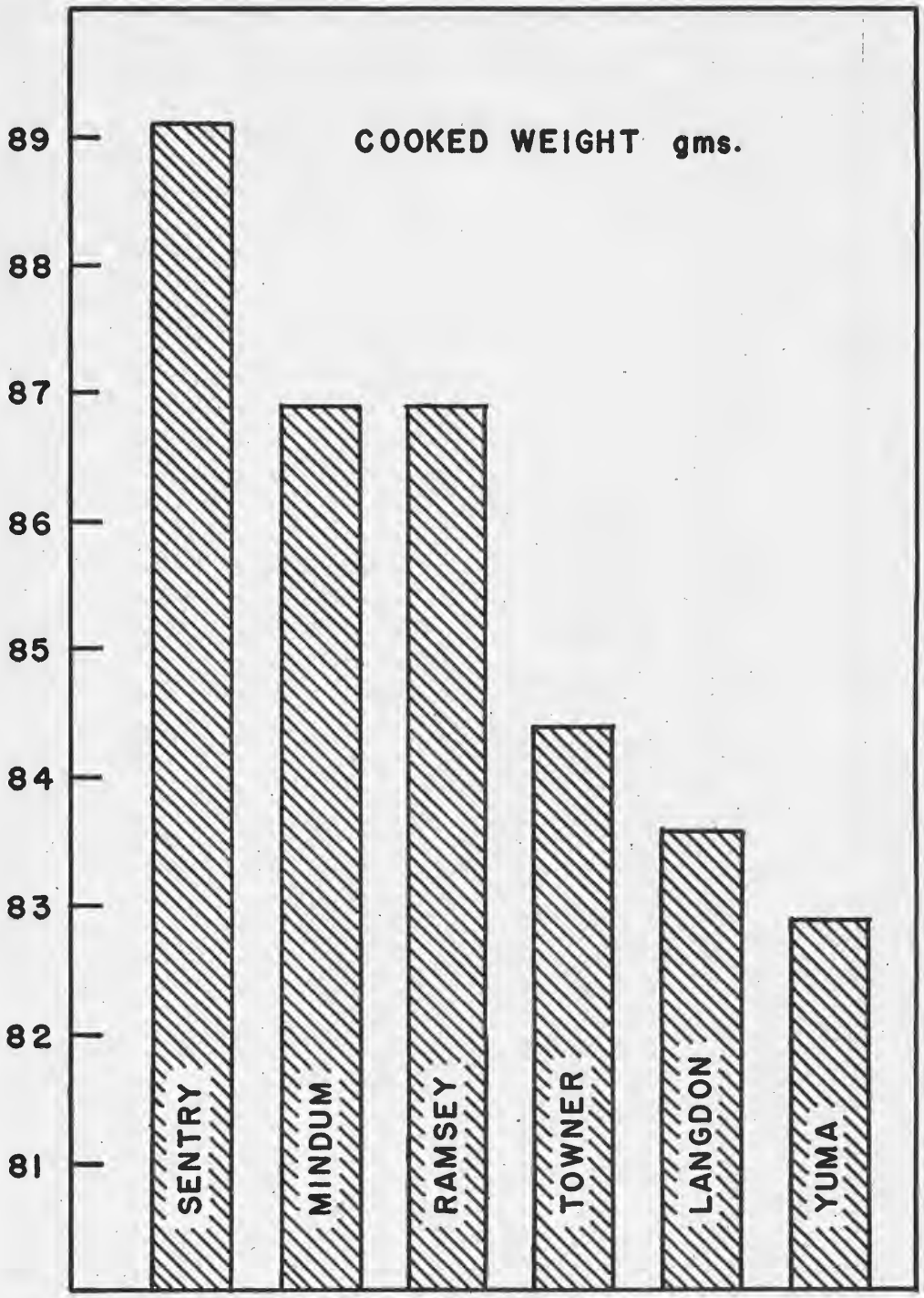

Fig. 3. Comparative values for macaroni cooked weight for 6 durum varieties.

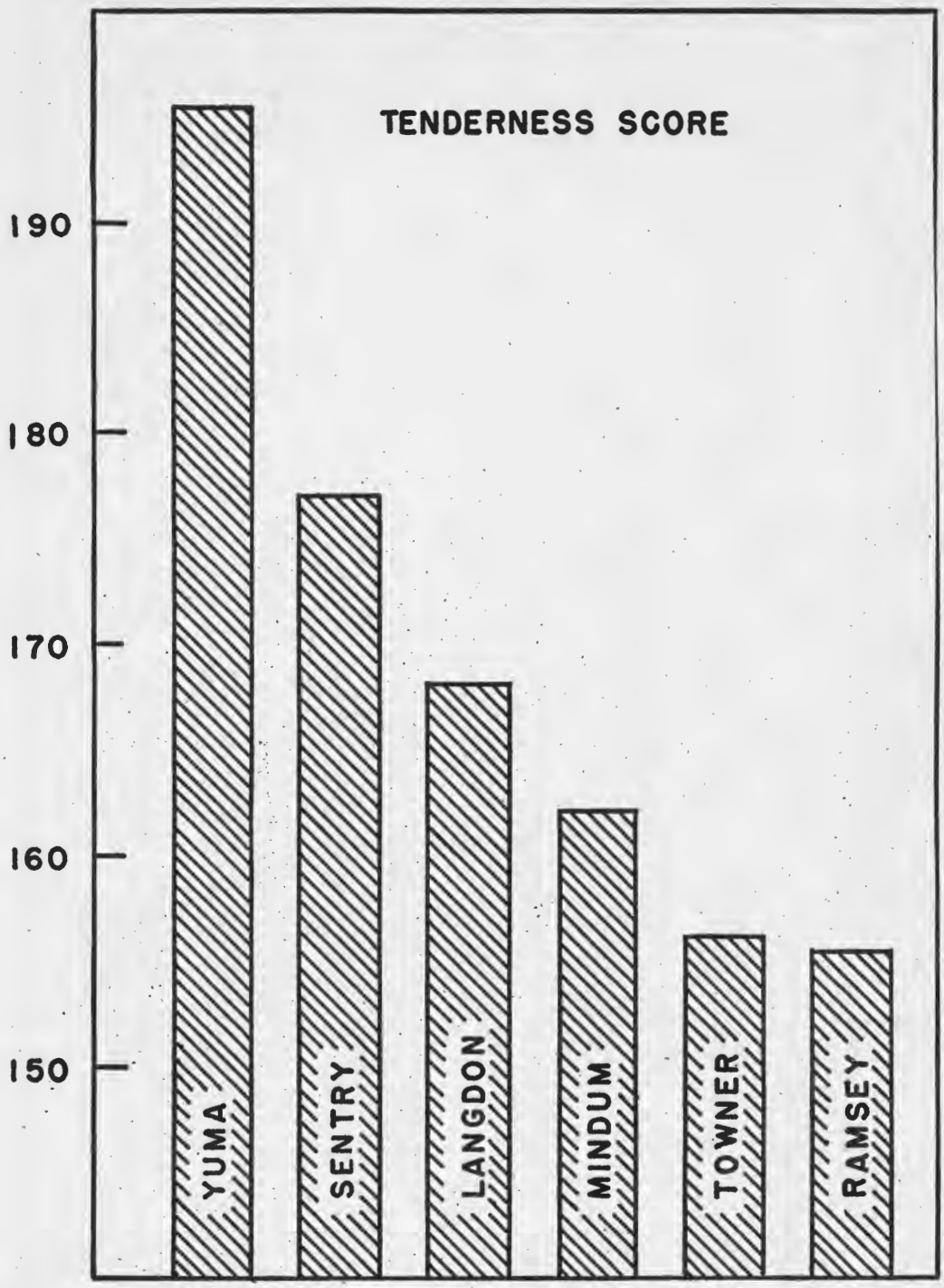

Fig. 4. Comparative tenderness scores of cooked macaroni for the 6 durum varieties.

tern would be preferred. Mixing patterns, apart from their processing significance, indicate gluten strength.

Residue left in the cooking water did not vary greatly among the varieties. Harris and Sibbitt (3) showed there was no significant difference in residue among durum wheats which were acceptable in milling and processing quality. Their conclusion is verified by the values in Table 1. The variations arose through sampling and experimental errors and do not reflect a real difference among the varieties. For this reason the results for residue are not shown in a figure.

Larger variations among varieties were found in the cooked weights of the macaroni and these were significant, as pointed out before by Harris and Sibbitt. The data are represented in Fig. 3. Sentry had the highest cooked weight while Ramsey and Mindum had exactly the same. Yuma had the lowest in spite of its strong gluten. High cooked weight is desirable because it is evidence that little disintegration and loss occurred during cooking. Cooking loss is largely caused by starch solubilization while the macaroni is being cooked. A small loss means that more of the macaroni remains in the cooked form.

Table 1 and Fig. 4 provide information also on the tenderness score of the cooked macaroni. Higher scores represent "tougher" macaroni, although no limits of acceptability have been established. Mean or average values would be more desirable as they represent macaroni neither tougher nor softer than usual. Yuma would be judged as somewhat tough in the present comparisons, with Sentry next, although Sentry was softer in dough and gluten properties. Towner and Ramsey were the more tender of the 6 varieties as judged by the tenderness score.

A possible disadvantage of this method of rating for tenderness is obvious. It is performed by equipment and is not derived from individual judgments by actual chewing of the material. On the other hand it yields data that can be replicated closely and is not influenced by personal opinion.

Table 2 shows the maximum and minimum values for each of the quality properties for each variety. For protein content the values extend from a maximum of 18.7 percent to a minimum of 10.7 percent or a range of 8.0 percent. The lowest value occurred with Mindum, while the highest maximum and minimum results were obtained from Yuma.

TABLE 2. Maximum and Minimum Values for Durum Wheat Quality for Each Variety

Varieties	Wheat protein content(1)		Visual color score of macaroni		Mixing pattern		Residue(1)		Cooked weight(1)		Tenderness score	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	%	%					gms.	gms.	gms.	gms.		
Sentry	17.7	12.4	10.0	7.5	Very Weak (2)	Very Weak (2)	1.24	0.88	97.5	80.2	232.9	123.6
Langdon	18.0	12.3	10.0	7.5	Medium (5)	Weak (3)	1.31	0.79	90.6	76.5	244.9	116.2
Ramsey	18.0	12.0	10.0	5.0	Medium (5)	Weak (3)	1.27	0.80	93.5	80.7	227.5	111.9
Mindum	17.4	10.7	10.0	5.0	Strong (7)	Weak (3)	1.24	0.84	92.4	77.4	232.7	107.2
Yuma	18.7	13.2	9.5	7.0	Very Strong (8)	Medium (5)	1.35	0.75	87.7	76.0	274.1	143.4
Towner	17.9	12.5	9.0	4.0	Medium (5)	Weak (3)	1.31	0.80	90.4	77.4	216.6	121.0

(1)Expressed on 13.5% moisture basis.

In the macaroni color score, values ranged from 10.0 to 4.0, a variation of 6.0, with Sentry and Langdon showing the highest and Towner the lowest scores. All the Sentry and Langdon scores would be satisfactory. A marked range was evident between the high and low mixing scores. Yuma, with a score of 8, was the highest. Sentry had the lowest maximum and minimum scores, 2.0 for both. Mindum had the largest range between high and low scores, with a difference of 4. There was also a large variation in residue between the high and low values for all varieties. These differences in residue disappeared when the varietal averages were calculated and are not evident in Table 1.

Sentry had the highest cooked weight maximum, but the second highest minimum. Both values were lowest for Yuma. Yuma had the highest tenderness score. The lowest value was obtained with Mindum, although Ramsey was not much higher.

These large differences or ranges in quality values were probably caused by environmental factors during seasonal growth and show the marked influence that these factors, as weather and soil, have on durum wheat quality.

Table 3 provides preliminary information on the quality of 4 new durum hybrids grown in experimental plots for the first time in 1957. Since the data are averages of only 2 samples it is difficult to draw definite conclusions. The new durums appear to be satisfactory in color score but, except for LD 392, were weak in dough mixing properties. Hybrids LD 393 and LD 389 were high in cooked residue. All were average for cooked weight and tenderness score. Further tests on these wheats are planned for the 1958 crop.

SUMMARY AND CONCLUSIONS

The cooking quality of 4 relatively new durum varieties grown for 4 years in experimental plots in North Dakota was evaluated. Little difference in the amount of residue remaining after cooking was found among varieties, but there were important differences among varieties in weight and tenderness of the cooked macaroni.

TABLE 3. Variety Means for Durum Grown only at Fargo and Langdon in 1957. Arranged in Order of Decreasing Macaroni Color Score Within Groups.

Varieties	Wheat protein content[1]	Visual color score of macaroni	Mixing pattern	Residue[1]	Cooked weight[1]	Tenderness score
	%			gms.	gms.	
Langdon	12.9	9.0	Med. weak (4)	1.21	81.9	137.6
Sentry	13.8	8.5	Very weak (2)	1.14	88.1	167.8
Ramsey	13.0	8.2	Med. weak (4)	1.10	84.5	143.4
Mindum	12.2	7.8	Med. strong (6)	1.03	84.5	167.4
Yuma	13.8	7.8	Strong (7)	1.19	84.9	198.7
Towner	12.0	7.2	Medium (5)	1.14	85.9	141.0
Average	13.1	8.1	Medium (4.7)	1.14	85.0	159.3
LD 392	12.8	8.8	Medium (5)	1.05	87.5	170.9
LD 393	12.6	8.8	Very weak (2)	1.52	90.1	141.6
LD 390	13.3	8.2	Very weak (2)	1.03	86.3	162.0
LD 389	12.5	8.0	Weak (3)	1.42	86.9	163.6

[1]Expressed on 13.5% moisture basis.

One of the new durums, Yuma, was the highest in cooked weight and produced the "toughest" macaroni as judged by a tenderness testing device. This variety also showed abnormal mixing properties but had acceptable color. Macaroni color is the most important single quality factor. The other 3 varieties appeared closer to the standards in cooked weight and tenderness score.

Preliminary tests for 4 unnamed hybrids showed that 2 were satisfactory in macaroni cooking quality.

Myrth Weiser, student assistant, performed the cooking tests.

LITERATURE CITED

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A NEW SELECTIVE CHEMICAL FOR WILD OATS

A new chemical now under test in the North Dakota Agricultural Experiment Station greenhouse may be the answer to our wild oat control problem.

Dr. E. A. Helgeson, botanist, says preliminary tests indicate it may be possible to kill wild oats in such growing crops as wheat, barley and flax without serious injury to the grain crops. When the oat plant is sprayed, its growth is stopped immediately, while the crop plants continue normal growth. After a month or so the wild oat plant twists and curls up and finally dies. The chemical, when available, will be comparable with 2,4-D in cost and in method of application. Its formula has not as yet been released.

Helgeson pointed out that, since the chemical has not been field tested, little is known about the effect of environmental conditions or stage of plant growth on practical field control. Even if the performance under field conditions is satisfactory it will take several years to get the product on the market for widespread use, since clearance by the U. S. Food and Drug Administration must be obtained.