A C T A A L I M E N T A R I A P O L O N I C A
Vol. XV (XXXIX), No. 3 1989

TADEUSZ HABER
MAŁGORZATA JARUGA
JERZY W. PĄTEK

ATTEMPTS TO UTILIZE WILD OAT (*AWENA FATUA L.*) IN CEREAL PROCESSING.
PART II. TECHNOLOGICAL TRIALS OF OBTAINING FLAKES FROM WILD OAT

Department of Cereal and Food Concentrates Technology, Warsaw
Agricultural University

Key words: cereal processing, wild oat, flakes production.

The results of the studies, obtained in part 1 of the present work [2] demonstrated that wild oat has many physical and commodity properties in common with commercial oat. Certain qualities, e.g. the content of total protein, are even superior in wild oat than in the commercial oat. These encouraging results were the reason for undertaking further trials of the poissible practical utilization of the grain of wild oat in cereal processing, and first of all, in the production of flakes.

EXPERIMENTAL MATERIAL

The experimental material in the present work was the following grain:

— wild oat (*Avena fatua L.*) obtained as a result of cleaning wheat grain before milling in Mill at Białołęka, cleaned then thoroughly by manual classification,

— commercial oat (Avena sativa), variety Rumak, from the 1985, harvest, obtained via the Poznań Plant Cultivation Centre, and

— mixture of the grain of various cereals, constituting a waste fraction, obtained during the cleaning of wheat before milling in Mill of Białołęka, additionally passed through the Brabender granotest and set of Vogl screens, with the aim to obtain a maximum concentration of the grain of wild oat but without manual cleaning (as when obtaining a pure fraction of wild oat).

The applied mixture of the grain of various cereals had the following composition:

wheat	0.15%
barley	6.35%
commercial oat	9.05%
wild oat	83.15%
broken grains of various cereals	1.30%

It seemed interesting to examine the possibilities of utilizing such a mixture of various cereals in which wild oat had the highest share and which it was not difficult to obtain. It was, however, obvious that the composition of such a mixture would be variable and would depend on the degree and type of contamination of the wheat from which it was isolated.

METHODS OF WORK

The studies started with the obtaining of oat flour. Milling was done using mill OC-112, applied for the disintegration of samples during studies employing Infrapid 31. The milling for whole meal flour was conducted at the width of the milling slot equal to 75 μm; before milling the grain was not conditioned.

The obtained flours were analysed and the degree of their integration was determined (screen analysis) as well as their colour and chemical composition (protein, fat, cellulose, humidity). In the studies, the same methods were employed as reported in the first part of the present elaboration [2], in the examination of oat grains.

For obtaining oat flakes, a laboratory flaker from the Central Laboratory of Processing Technology and Storage of Cereals in Warsaw, was utilized. The process of obtaining flakes was conducted by two methods. A diagram of the applied technological process is shown in Fig. 1.

In the first method, the chaffed grain was subjected to hydrothermal treatment in a laboratory pressure vessel, applying the following parameters: temperature (t) — 100-110°C, time (τ) — 6 min., pressure (p) — 0.13 MPa — humudity (h) — 20%.

Then, the grain was calcinated in a laboratory drier (parametrs of drying: $t = 80°C$, $\tau = 1.5$ h, $h = 7\%$) and was dehulled. The dehulled grain was again subjected to water steam treatment (parameters t: = 100°C, $\tau = 7$ min., p = atmospheric, h = 17-18%), then it was dried on spread filter papers and flaked in a mill with plain-bodied rolls. The final product was dried at room conditions, final humidity $h_f = 10\%$.

In the second method applied, the first two stages were ommitted, i.e. hydrothermal treatment and calcination (roasting) before the dehulling process, and then the procedure was the same as in the first method. The obtained flakes were subjected to an organoleptic evaluation both raw flakes (according to PN-82 (A-74037) and cooked flakes. The cooked flakes were prepared in the following way: 10 g of flakes were mixed with 100 cm^3 of slightly salted water and cooked for 3 min., then, 150 cm^3 of boiled milk and 0,8 g of butter were added. The thus prepared flakes were subjected to score organoleptic evaluation, the so-called preferential assessment, scale 1 to 5, in which:

1 score — bad
2 scores — unsatisfactory,
3 scores — satisfactory,
4 scores — good,
5 scores — a very good.

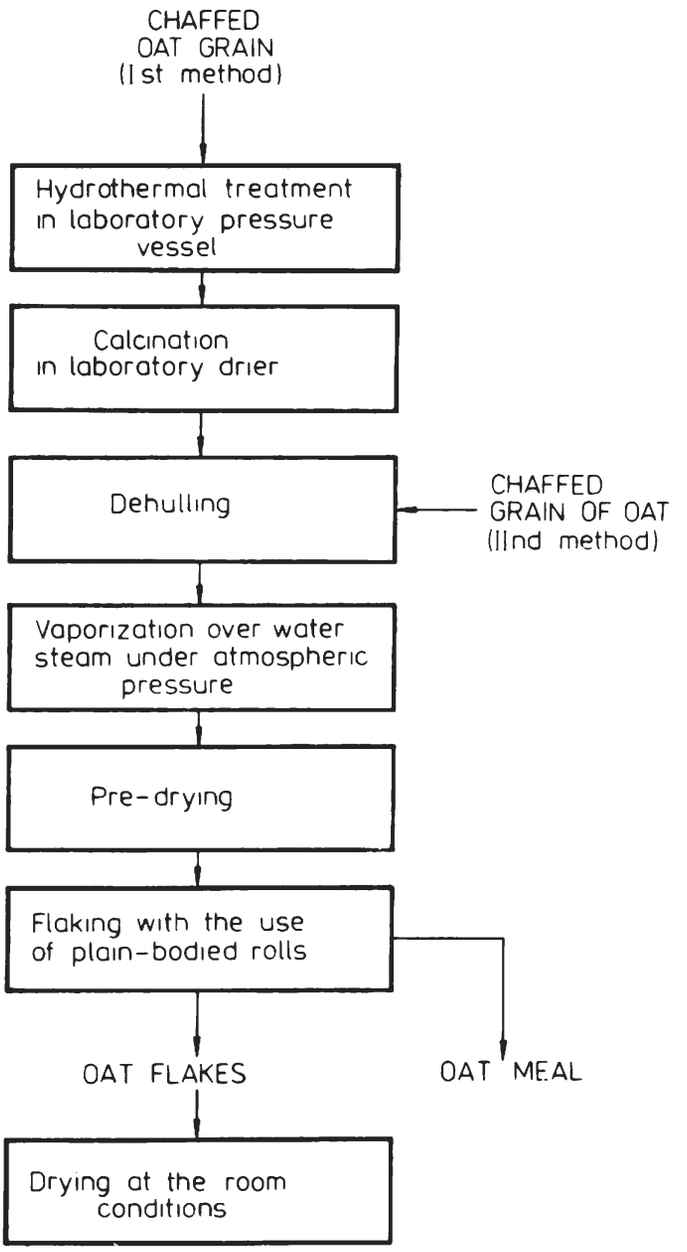

Fig. 1. Flow-sheet of flaking process employed in the study

Four properties were evaluated: appearance, smell (odour), taste and consistency, for which various coefficients of importance were adopted: 0.20; 0.24; 0.36 and 0.20, respectively. Ten persons took part in the evaluation.

Besides, the thickness of the flakes was determined (using a micrometer screw) together with their colour and chemical composition. The procedure was the same sa in the examination of grain and flour [2].

RESULTS AND DISCUSSION

CHARACTERISTICS OF OAT FLOUR

The studied samples of the commercial oat variety Rumak, of wild oat and of the mixture of grains of various cereals were subjected to milling, using a laboratory mill OC-112. As a result of milling, flours with an extract of 80% (approx), were obtained.

All the obtained flours had characteristic organoleptic properties. In terms of

organoleptic properties, no differences were practically found between meal from commercial oat and meal from wild oat.

Greater and more significant differences were found in the chemical composition of the flours (Table 1). First of all, it was stated that all the obtained flours were characterized by a high content of total protein, amounting to 15.8 to 18.4% DM. A higher content of total protein was found in flour, obtained from wild oat than commercial oat. In the flour obtained from the mixture of various cereals, there was a mean, more or less, level of protein which is most certainly, a consequence of the high share of wild oat (83.15%) in this sample.

Table 1. Chemical composition of oat meals

	Humidity (%)	Protein (% d.m.)	Starch (% d.m.)	Reducing sugars (% d.m.)	Ash (% d.m.)	10%-HCl insoluble ash (% d.m.)	Fat (% d.m.)	Cellulose (% d.m.)	Acidity ( )
Meal from wild oat	12.6	18.4	61.6	0.73	2.5	0.2	7.2	3.8	9.9
Meal from the mixture	12.3	17.7	64.2	0.78	2.4	0.2	6.8	3.5	9.3
Meal from the commercial oat	12.0	15.8	66.9	0.80	2.1	0.1	7.5	2.8	8.4

On the other hand, the highest content of starch was found in flour from commercial oat (66.9% DM) in comparison with the remaining three examined flours. The lowest strach content was found in flour obtained from wild oat (61.6% DM). This confirmed the known rule that the higher the amount of protein in cereals, the lower that of starch and vice versa.

No significant differences in the level of directly reducing sugars were stated though test amount of sugar was found in flour from the commercial oat and the smallest in flour from wild oat, similarly to starch. Similar relationships were noticed in the content of raw celluse but the differences in its level were considerably greater, (2.8-3.8% DM).

Small differences were found in the content of total ash and of 10% HCl — insoluble ash, however, as expected, fluor from wild oat was characterized by a higher level of both ashes.

Flour obtained from commercial oat revealed the highest content of fat, amounting to 7.5% d.m. From the tree flours studied, the lowest level of fat was found in flour obtained from a mixture of various cereals (6.8% d.m.) which should be ascribed to the presence of other cereals (barley, wheat) in this mixture.

Fluors obtained in the experiment, were screen analysed and the results are presented in Table 2. On the basis of this analysis, it was stated that flour obtained from the wild oat in comparison to flour obtained from commercial oat, featured a slightly higher content of particles greater than 250 μm, and simultaneously, a higher content of the smallest particles, (below 150 μm). It should be recalled that wild oat used in this work, revealed a considerably smaller hardness than the commercial oat. This hardness was, respectively: 250 and 300 B.U., or 30.0 and 51.7 N (see part I of the study). It was therefore to be expected that the results of the screen analysis would be reverse. If it was not the case, this was probably the consequence of the higher content of protein in wild oat, or of the differences in the internal structure of the two oats.

Table 2. Screen analysis of meal (overtails, in %)

Meal from: / Screen, mesh size	Wild oat	Mixture of various grains	Commercial oat
315	54.4	55.0	53.0
250	8.8	9.0	8.8
180	15.0	10.7	20.5
150	2.5	2.3	6.4
105	13.0	10.6	8.0
Sieving	2.0	6.0	0.4

CHARACTERISTICS OF THE FLAKING PROCESS AND CHEMICAL COMPOSITION AND THE SELECTED PHYSICAL PROPERTIES OF THE OBTAINED FLAKES

The grain of wild oat, of commercial oat and of the mixture of grains of various cereals was utilized, first of all, for producing flakes. As already mentioned, the flaking process was conducted by two methods, with the application of hydrothermal treatment or without it, according to the flow-sheet presented in Fig. 1. Data characterizing the flaking process are listed in Table 3.

The hydrothermal treatment of the grain of chaffed oat, employed in the first method, caused a loosening of bonds between the hull and the grain, which had a distinct effect on the increase of the dehulling process yield. Owing to this procedure, the yield of the dehulling process of wild oat, of the mixture of various cereals and of commercial oat was 70.0, 71.0 and 75.0%, respectively. In the second method, i.e. without hydrothermal treatment, the amount of the dehulled grain was by 6-7% lower and for the particular samples it was 64.0, 66.0 and 68.0%, respectively.

The yield of the flaking process in both methods was similar and it amounted from 98 to 99% for all samples.

Table 3. Characteristics of flaking process

Balance of flaking	Grain of oat processed acc. to the first method			Grain of oat processed acc. to the second method		
	wild oat grain	mixture grain	commercial grain	wild oat grain	mixture grain	commercial grain
Amount of grain (g)	200.0	200.0	200.0	200.0	200.0	200.0
Amount of dehulled grain (g)	140.0	142.0	150.0	128.0	132.0	136.0
Amount of dehulled grain in relation to the whole grain (6)	70.0	71.0	75.0	64.0	66.0	68.0
Amount of flakes (g)	137.2	139.2	147.0	126.8	129.4	134.7
Amount of flakes in relation to the whole grain (%)	68.6	69.6	73.5	63.4	64.7	67.4
Amount of flakes in relation to the hulled grain (%)	98.0	98.0	98.0	99.0	98.0	99.0
Weight of the oat meal (g)*)	2.6	2.8	4.6	1.3	2.6	2.7
Weight of meal (%)	1.9	2.0	3.1	1.0	2.0	2.0
Losses (%)	2.0	2.0	2.0	1.0	2.0	1.0

*) Sift through a silk screen, with 150 μm meshes

All flakes obtained by the first method, regardless of the oat used for their production, contained a higher amount of meal in comparison with flakes obtained by the second method. The only exception were flakes obtained from the cereal mixture, in which, irrespectively of the production method applied, the content of meal was equal and amounted to 2.0%. The content of oat meal in flakes obtained from wild oat was as follows: in flakes obtained by the first method — 1.9% and by the second method — 1,0% while in flakes made from commercial oat, it was 3.1 and 2.0% respectively. It should be remembered that the Polish standard (PN-82/A-74037) allows no more than 2.0% of meal in oat flakes.

The above results were affected, in a decisive way, by the technology of flakes production. In the grain subjected to the action of water steam, temperature and pressure, a partial conversion of starch into dextrins and simple sugars, a partial degradation of fats and a hydrolysis of proteins take place which has a direct influence on the cohesion of the final product, i.e. flakes and therefore, on the content of the oat meal [1, 3, 4, 5].

The organoleptic evaluation of raw flakes obtained from wild and commercial oats and of the mixture of various cereals produced according to the first

method, revealed that they had a specific (slightly nut-like) flavour. Flakes made from wild oat had a golden-white colour, were small and easily crushed. Flakes from the commercial oat and from the mixture of various cereals were characterized by a similar colour but the latter had an unfavourable marked colour reminding mottled spots of wheat meal which was probably caused by the presence of wheat in the mixture. Flakes from the commercial oat had a looser consistency, they were greater but simultaneously, they contained a higher share of oat meal.

Flakes obtained by the second method revealed a slight but distinct raw taste, they had a greater surface, were less brittle and perhaps due to this reason they contained a smaller amound of meal in comparison with flakes obtained according to the first method.

For a complete characteristic of flakes, the measurement of their thickness were carried out. It was shown that flakes from wild oat had a smaller thickness than flakes obtained from commercial oat, regerdless of the production method applied. It was observed that the flakes produced by the second method had a more even thickness, the difference being only ± 0.10 mm, whereas in flakes obtained by the first method, this deviation was twice as high.

Table 4 shows the colour characteristics of the obtained flakes and also, for comparison, the colour of the chaffed and dehulled grain, and of meal. From all the examined samples (from grain to flakes), the grain of wild oat featured the darkest colour (brightness 11.9) while the grain of commercial oat was the brightest (brightness 28.7). The distinctly dark colour of the grain of wild oat may be a discouraging factor in processing. However, dehulling of the grain was sufficient to find out that the colour of the obtained grains of wild oat as well as of commercial oat revealed a small difference; their brightness was 25.8 and 26.7, respectively. The dehulled grain of both oats was conciderably brighter than the dehulled grain of the cereal mixture.

Among the flours, the brighest colour was the one obtained from wild oat and among the flakes — those obtained from commercial oat. These results may point to certain differences in colour between the internal endosperm and its outer layer in both examined oats. The obtained results may suggest that the internal endosperm of wild oat is brighter than in case of the commercial oat, hence, the meal obtained from the former was the brightest meal. In case of the outer parts of the endosperm the situation is reverse what is evidenced by the colour of both dehulled grain ond flakes.

The colour of the flakes was much more differentiated. First of all, it was stated that all flakes obtained by the second method were brighter than analogical flakes obtained by the first method. This was presumably due first of all- to hydrothermal treatment. In each case, the flakes from the commercial oat were the brightest, and those from wild oat were the darkest. In both methods, flakes obtained from the mixture of various cereals were the least differentiated in respect of colour.

For a complete characterization of the flakes, they were chemically analysed and the results are presented in Table 5.

On the basis of chemical analysis, it was stated that the obtained flakes were characterized by a high content of total protein, from 13.1 to 16.2% d.m. The highest level of protein (15.6-16.2% d.m.) was found in flakes obtained from wild oat and the lowest in flakes obtained from commercial oat, variety Rumak (13.1-13.5% DD). Flakes obtained from the mixed grain of various cereals contained mean quantities of protein (14.8-15.5% d.m.). All flakes obtained by the second method i.e. without hydrothermal treatment had a higher content of protein, in the average by 0.4-0.6% and the greatest difference was stated in case of flakes from wild oat and the smallest in case of commercial oat. The above data show that hydrothermal treatment caused losses in the total content of protein in flakes.

The content of starch in all samples was more or less similar (65.6-70.8% d.m.) but a higher content of protein was always accompanied by a lower content of starch.

Table 4. Characteristics of the colour of grain, meal and flakes

Sample		Hue ($= \lambda$)	Saturation	Brightness
Chaffed grain	Wild oat	575	0.24	11.9
	Mixture of various grains	575	0.35	20.9
	Commercial oat	580	0.80	28.7
Dehulled grain	Wild oat	581	0.35	25.8
	Mixture of various grains	596	0.39	20.7
	Commercial oat	579	0.39	26.7
Meal	Wild oat	581	0.07	59.7
	Mixture of various grains	581	0.07	53.1
	Commercial oat	579	0.07	53.1
Flakes (Ist method)	Wild oat	574	0.15	44.7
	Mixture of various grains	757	0.10	57.4
	Commercial oat	555	0.05	57.8
Flakes (IInd method)	Wild oat	574	0.10	44.9
	Mixture of various grains	583	0.04	57.7
	Commercial oat	583	0.04	61.0
Standard		576	0.16	82.8

Table 5. Chemical composition of oat flakes

Product	Himidity (% d.m.)	Protein (% d.m.)	Starch (% d.m.)	Reducing sugars (% d.m.)	Ash (% d.m.)	10%-HCl -insoluble ash (% d.m.)	Fat (% d.m.)	Cellulose (% d.m.)	Acidity (°)
Flakes from wild oat Ist method)	11.8	15.6	66.7	0.76	2.4	0.2	6.3	3.7	5.2
Flakes from wild oat (IInd method)	12.3	16.2	65.6	0.71	2.4	0.2	6.5	3.6	6.3
Flakes from mixture (Ist method)	11.5	14.8	67.8	0.72	2.3	0.2	6.2	3.6	5.5
Flakes from mixture (IInd method)	12.3	15.5	67.0	0.78	2.4	0.2	6.4	3.4	6.5
Flakes from commercial oat (Ist method)	11.7	13.1	70.8	0.89	2.0	0.1	6.6	2.8	5.3
Flakes from commercial oat (IInd method)	12.0	13.5	70.3	0.87	2.1	0.1	6.8	2.8	5.8

Attention should be also drawn to the content of fat in flakes and their acidity. The highest level of fat was found in the commercial oat flakes: 6.6-6.8% d.m. which is a consequence od the higher content of this component in the grain. In all samples of flakes obtained by the first method, the content of fat was by 0.2% lover than in flakes produced by the second method. The same relationship was observed in the total acidity of flakes and the differences amounted to 0.8-1.1°. It may be, therefore assumed that hydrothermal treatment employed in the first method favoured the degradation of fats and inactivation of lipase which had an influence on the content of fat in the flakes and also on their acidity.

THE CONSUMER'S EVALUATION OF COOKED OAT FLAKES

The last stage of the work was the organoleptic evaluation of the obtained flakes by the consumer, after cooking. In order to get a wider scale of quality of flakes for evaluation, for the sake of comparison commercial oat flakes (ordinary and instant were) also included. The results of the score evaluation, the so-called preferential assessment of the quality of the flakes after cooking, are presented in Fig. 2.

The analysis of the results, shows that none of the flake samples received a „bad" evaluation which automatically disqualifies the tested food product.

The highest amount of „very good" evaluations (12 evaluations) was obtained by flakes from wild oat produced by the first method while „good" evaluations were also obtained by wild oat flakes but produced by the second method (26 evaluations). The latter flakes obtained the highest number of „very good" and „good" evaluations (32 evaluations) and the smallest number was obtained by commercial instant flakes (18 evaluations).

Considering the coefficients of importance (appearance — 0.20; smell — 0.24; taste — 0.36 and consistency — 0.20), the highest score evaluation was obtained by wild oat flakes produced by the first method (36.90 scores) and then, by the second method (36.52 scores). The lovest evaluations were obtained by the commercial flakes: ordinary (33.38 scores) and instant (31.95 scores).

CONCLUSIONS

On the basis of the conducted studies, the following conclusions may be drawn:

1. The grain of wild oat (*Avena fatua L.*) may be successfully applied in cereal processing, including the production of flakes.

2. Flakes produced from wild oat were superior, in many respects, to flakes obtained from commercial oat, variety Rumak, obtained under the same conditions. This concerned, first of all, the content of total protein (15.6-16.2% d.m. in comparison with 14.8-15.5% d.m.) and also organoleptic properties.

3. The hydrothermal treatment of the chaffed oat grain contributed to an

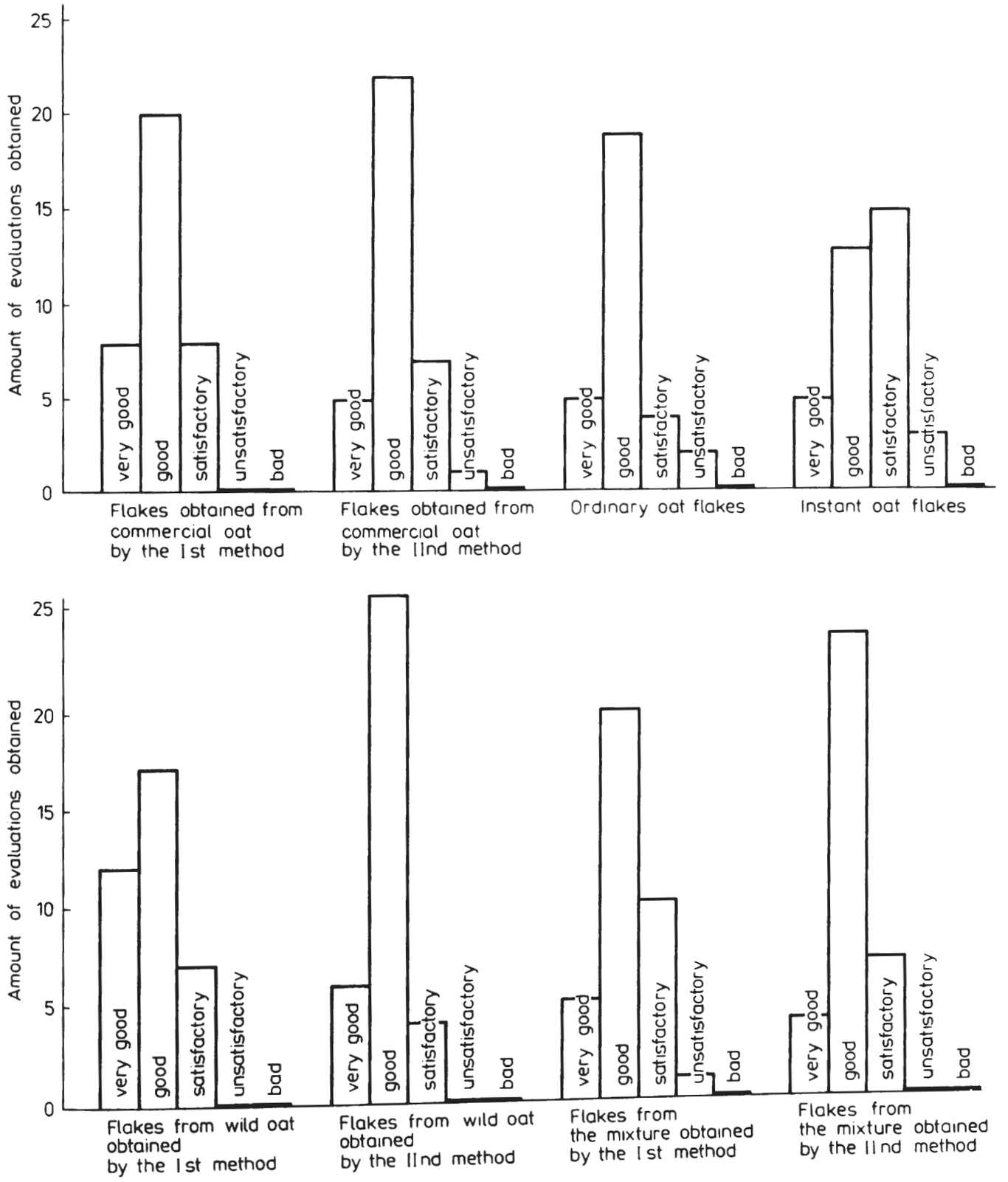

Fig. 2. The numer of evaluations (from very good to bad) obtained by the particular examined flakes

increase of the yield of the dehulling process by 5-7% in comparison with the second method in which this treatment was not used. The hydrothermal treatment had an influence on the lowering of the protein content in flakes (by about 0.6% d.m.), of fat (by 0.2% d.m.) and total acidity (by about 1.0°).

4. The mixture of the grain of various cereals which is a waste product obtained during the cleaning of grain before milling and in which the share of the grain of wild oat exceeds 80%, may be successfully applied in cereal processing, among other things, in the production of flakes.

LITERATURE

1. Grzesiuk S., Kulka K.: Fizjologia i biochemia nasion. PWRiL, Warszawa 1981.
2. Haber T., Jaruga M., Kocoń J., Pątek J. W.: Acta Alimentaria Polonica 1989, 15/XXXIX (3),
3. Zarys technologii zbóż i strączkowych jadalnych, part I. PWN, Warszawa 1967.
4. Kaczmarek A.: Przegl. Zboż.-Młyn., 1961 (1), 23
5. Sosulski F. W., Sosulski K., Olson I. P.: Canadian Institute of Food Science and Technology Journal., 1985, 18, 220.

Manuscript received: February 1988
Authors address: 03-849 Warszawa, Grochowska 272

T. Haber, M. Jaruga, J. W. Pątek

PRÓBY WYKORZYSTANIA DZIKIEGO OWSA (*AVENA FATUA L.*) W PRZETWÓRSTWIE ZBOŻOWYM. II. PRÓBY TECHNOLOGICZNE OTRZYMYWANIA PŁATKÓW Z OWSA DZIKIEGO

Katedra Technologii Zbóż i Koncentratów Spożywczych SGGW-AR, Warszawa

Streszczenie

Zbadano możliwości wykorzystania dzikiego owsa (*Avena fatua L.*) do otrzymywania płatków. Równolegle otrzymywano płatki z owsa handlowego odmiany Rumak oraz z mieszanki ziarna różnych zbóż stanowiącej frakcję w procesie czyszczenia pszenicy przed przemiałem. Mieszankę dodatkowo przepuszczono przez „granotest" Brabendera w celu zwiększenia w niej koncentracji dzikiego owsa, tak że jego zawartość wynosiła ponad 83%. Interesujące wydawało się zbadanie możliwości wykorzystania takiej mieszanki, w której dziki owies miał największy udział, a uzyskanie której było znacznie łatwiejsze niż czystej frakcji dzikiego owsa. Proces technologiczny otrzymywania płatków prowadzono dwiema metodami, których schematy przedstawiono na rys. 1. Różnica między metodami polegała głównie na tym, że albo stosowano obróbkę hydrotermiczną ziarna oplewionego, albo nie.

W wyniku przeprowadzonych badań stwierdzono, że dziki owies może być z powodzeniem wykorzystany jako tani, wysokobiałkowy surowiec do produkcji płatków, stanowiący cenne urozmaicenie zestawów śniadaniowych produkowanych przez krajowy przemysł zbożowy. Płatki uzyskane z dzikiego owsa pod wieloma względami przewyższały płatki tradycyjne z owsa handlowego. Dotyczyło to m.in. zawartości białka ogółem, wyższej o ok. 0,8% sm, a także cech organoleptycznych.

Z dwóch stosowanych metod otrzymywania płatków z dzikiego owsa korzystniejsza wydawała się metoda przewidująca hydrotermiczną obróbkę ziarna oplewionego. Zastosowanie tej metody wpływało wprawdzie na obniżenie w płatkach zawartości białka ogółem i tłuszczu odpowiednio o ok. 0,6 i 0,2% sm, a także kwasowości ogólnej o ok. 1,0°kw, ale jednocześnie wpłynęło na podwyższenie (o 5-7%) wydajności procesu łuszczenia. Stwierdzono również, że do produkcji płatków może być wykorzystana mieszanka ziarna różnych zbóż, której 80% stanowi dziki owies. Płatki uzyskane z takiego surowca tylko w niewielkim stopniu ustępowały płatkom uzyskanym z dzikiego owsa.