THE QUALITY PROPERTIES OF AUTOTETRAPLOID BUCKWHEAT KERNEL

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The methods of buckwheat cultivation, the availability of soil nutrients, temperature, humidity and other ecological conditions certainly affect buckwheat qualities. The difference in yield could be the important discriminating parameter between diploid and tetraploid buckwheat. Details are not yet known, if there are important differences in quality and utilization value between diploid and its autotetraploid, as well as diploid tatary varieties. Physical and chemical properties of buckwheat kernels and flours were analyzed. The common autotetraploid variety Yuqiao 1 has much larger kernels than its diploid Mudanqiao and tatary variety Yuqiao 6-21, but the centigrade variance (CV%) in kernel weight of the tetraploid variety was also greater. The different fractions of flour prepared to different ways of milling may have different chemical compositions and also different value of nutrition and utilization. There are no obvious differences in protein, amino acids, ash, minerals and crude fiber content between common diploid and its autotetraploid as well tatary cultivation. Buckwheat flour has a relatively higher content of ash, fiber, amino acids and minerals than wheat flour. The gelatinization temperature and resistance of buckwheat flour are higher than that of wheat flour Meneba.

buckwheat; common buckwheat (*Fagopyrum esculentum*, Moench); tatary buckwheat (*Fagopyrum tataricum* L. Gaertn); quality property; nutritional value

INTRODUCTION

Buckwheat belongs to the knotweed family, buckwheat genus. The common cultivation species are diploid common, tatary and cymosum buckwheat. Among them, the widest speeding one is the common diploid. The common diploid variety has indefinite inflorescence for sensitivity illumination, unusual long style, cross pollination and especial long florescence. These characters of common diploid bring in low fructification rate, difference of the

mature and of the grain weight. Especially, it has a harmful effect on the increase of yield, decorticating, milling and food production. Recently, the buckwheat breeders have increased the buckwheat yield and improved the properties of grain through definite inflorescence type and selected autotetraploid variety. Nowadays, autotetraploid and tatary varieties have been applied to production.

In this paper the differences of grain properties, milling quality and nutrition compositions have been studied in diploid, its autotetraploid and tatary varieties, and the nutrition composition which contrast to wheat flour analyzed. The goal of the research lies in finding out the variant character of autotetraploid grain quality and providing the essential theory and technology for the buckwheat breeding and food production.

MATERIALS AND METHODS

Sample sources

The tetraploid variety Yuqiao 1 (4X) has been breaded by systematic selection after its diploid gnome was doubled through autumn crocus alkali. The samples of tetraploid Yuqiao 1, diploid Mudanqiao (2X) and tatary Yuqiao 6-21 (2X) varieties, harvested from new strains tested in 1992, were provided for 3 kg by Yulin Institute for Agricultural Science Shaanxi, and wheat flour by Brabender OHG, Duisburg, Germany.

Analysis methods

Milling: moisture 16%;
milled by Cyslote Z1093 Sample Mill;
screened through CQ20 (1XX), CB30 (6XX), CB36 (8XX);
screen with 3 replicates per variety.
Protein content: VS-KTP Nitrogen Autoanalyzer, Japan.
Protein content (%) = N x 6.25
Protein fraction: following the Osborne principle.
Fiber content: Fiber analyzer, Sweden.
Ash content: ICC-Method No. 104.
Amino acids: Amino acid analyzer, 121 MB, USA.
Minerals: Atomic absorption spectrophotometer, National 180-80, Japan.
Viscograms: ICC-Method No. 126.

RESULTS

Physical properties of buckwheat kernel

According to the results of single kernel weight in an amount of 1 000 kernels of three buckwheat varieties, we can see that the common autotetraploid variety Yuqiao 1 has much larger kernel than its diploid Mudanqiao, and twice as large as the tatary variety Yuqiao 6-21 (Tab. I).

The centigrade variance (*CV%*) and the range variances (*R*) of single kernel weight are highest for the tetraploid variety, as well as the difference of single kernel weight, but the degree of order is the worst. Although the kernel of tatary Yuqiao 6-21 is the smallest, the centigrade variance and the range variance are the lowest, the kernel is nearly in weight, and the test weight is the highest.

I. Single grain weight and test weight of buckwheat varieties

Variety	Single grain weight				Test weight
	X	*S*	*CV*	*R*	
	(mg)	(mg)	(%)	(mg)	(g/l)
Yuqiao 6-21	24.9	3.7	14.9	14.0–38.0	732.8
Mudanqiao	34.8	5.3	15.3	15.0–51.0	591.1
Yuqiao 1	51.7	12.4	24.0	20.0–81.0	676.5
Mean	37.1	7.1	18.1	–	666.8

Milling quality and distribution of main components in buckwheat flour of different grades of fineness and buckwheat bran

According to the Chinese Standard for wheat flour fineness, the mill extraction and fiber, protein and ash content in flour of different fineness were quantitatively analyzed (Tab. II).

The fine flour extraction (< CB36) of the tatary variety Yuqiao 6-21 is the highest under identical milling conditions amounts to 72.8%, the fine flour extraction of tetraploid and diploid are the lowest on the contrary, and they come close to each other (Tab. II). The coarse flour extraction (< CQ20, > CB36) of diploid Mudanqiao and tetraploid Yuqiao 1 are higher than that of tatary Yuqiao 6-21, and the buckwheat bran (> CQ20) of tetraploid variety is the highest among the three buckwheat varieties.

II. Mill extraction, flour fineness, protein, fiber and ash content of buckwheat varieties (% of d.m.)

Variety	> CQ20	> CB30	> CB36	< CB36
Mill extraction				
Yuqiao 6-21	15.6	7.1	4.5	72.8
Mudanqiao	13.4	14.1	13.5	58.5
Yuqiao 1	16.2	9.6	16.3	58.0
Mean	15.1	10.3	11.4	63.1
Protein content				
Yuqiao 6-21	5.75	21.26	22.08	8.76
Mudanqiao	7.44	22.51	23.23	9.32
Yuqiao 1	7.27	21.12	13.99	10.48
Mean	6.82	21.63	19.77	9.52
Fiber content				
Yuqiao 6-21	44.02	14.60	9.28	3.08
Mudanqiao	32.58	9.77	1.27	0.00
Yuqiao 1	36.34	16.09	5.16	1.86
Mean	37.65	13.49	5.24	1.65
Ash content				
Yuqiao 6-21	2.18	2.42	4.44	3.30
Mudanqiao	2.04	4.06	3.90	2.40
Yuqiao 1	1.98	3.70	2.20	1.73
Mean	2.07	3.39	3.51	2.48

Fiber content was significantly reduced with the increase of flour fineness (Tab. II). The fiber content of fine flour that pass through CB36 screen is 0.00–3.08%, and diploid Mudanqiao flour has not enough fiber to be determined. Above all, the fiber content of diploid Mudanqiao is the lowest and that of tatary Yuqiao 6-21 is the highest.

Protein content in fine flour of tetraploid Yuqiao 1 is the highest, on the contrary, that of tatary Yuqiao 6-21 is the lowest (Tab. II). In coarse flour has much higher protein than that of fine flour, otherwise, the buckwheat bran remains 5.75–7.44% protein.

Ash content is the highest in coarse flour, lower in fine flour and lowest in buckwheat bran. Generally, the ash content in flour of different fineness of the tetraploid Yuqiao 1 is lower than that of other varieties (Tab. II).

Protein fractions

The analysis of protein fractions of three buckwheat flours shows that buckwheat flour is rich in albumin, the average of which is 36.8%, and it ishigher than that of wheat flour (14.3%). The albumin content of diploid Mudanqiao is the highest, but that of tatary Yuqiao 6-21 is the lowest (Tab. III).

The range variance of globulin shows little change between varieties (Tab. III). Except that tatary Yuqiao 6-21 has low globulin, there is no clear difference between tetraploid Yuqiao 1 and diploid Mudanqiao.

Comparison with wheat flour, buckwheat flour is very poor in prolamin, the average is only 2.0%. Glutelin contents of three buckwheat varieties show no clear difference, but the glutelin content is much lower than that of wheat flour (Tab. III).

III. Protein content and fractions of buckwheat varieties and wheat flours (< CB36)

Variety	Protein content (% of d.m.)	Protein fractions (% of protein)			
		albumin	globulin	prolamin	glutelin
Yuqiao 6-21	8.76	31.8	11.4	2.3	25.7
Mudanqiao	9.32	42.3	14.7	2.1	24.5
Yuqiao 1	10.48	36.4	14.1	1.7	26.1
Mean	9.52	36.8	13.4	2.0	25.4
Meneba	13.8	14.3	11.8	33.9	37.3

Amino acids

Tab. IV shows the contents of 17 amino acids of three buckwheat flours and one wheat flour. When amino acid content is expressed by percentage of dry substance, the amino acid contents of tetraploid Yuqiao 1 are close to or higher than those of diploid Mudanqiao, except lysine. Given in per cent of protein, the amino acid contents are very close to diploid Mudanqiao, except that lysine and cystine are slightly lower compared with tatary Yuqiao 6-21, theamino acid contents of Yuqiao 1 are also close to those of tatary except that lysine is slightly lower and that cystine and methionine contents are slightly higher.

The lysine and methionine contents of buckwheat flour are higher than that of wheat flour, specially lysine, which is twice as much than that of wheat flour. On the other hand, the aspartic acid and arginine contents of buckwheat are obviously higher than those of wheat flour, but the glutamin acid and

IV. Amino acid content of buckwheat varieties and wheat flour (< CB36; 1 – % of d.m.; 2 – % of protein)

Amino acid	Yuqiao 6-21		Mudanqiao		Yuqiao 1		Meneba	
	1	2	1	2	1	2	1	2
Asp	0.823	9.39	0.847	9.09	0.921	8.79	0.527	3.82
Thr*	0.299	3.41	0.304	3.26	0.334	3.19	0.309	2.24
Ser	0.363	4.14	0.362	3.88	0.410	3.91	0.535	3.88
Glu	1.213	13.84	1.346	14.44	1.531	14.61	4.194	30.39
Pro	0.514	5.86	0.492	5.28	0.635	6.06	2.076	15.04
Gly	0.407	4.65	0.430	4.61	0.476	4.54	0.376	2.72
Ala	0.318	3.63	0.338	3.63	0.351	3.35	0.304	2.20
Cys	0.039	0.45	0.111	1.90	0.072	0.69	0.166	1.20
Val*	0.239	2.73	0.230	2.47	0.265	2.53	0.529	3.83
Met*	0.042	0.48	0.058	0.62	0.066	0.63	0.043	0.31
Ileu*	0.294	3.36	0.274	2.94	0.304	2.90	0.386	2.80
Leu*	0.517	5.90	0.507	5.44	0.580	5.53	0.770	5.58
Tyr*	0.151	1.72	0.145	1.56	0.179	1.71	0.320	2.32
Phe*	0.350	4.00	0.335	3.59	0.388	3.70	0.577	4.18
Lys*	0.522	5.96	0.523	5.61	0.479	4.57	0.230	1.67
His	0.230	2.63	0.219	2.35	0.218	2.08	0.237	1.72
Arg	0.631	7.20	0.755	8.10	0.849	8.10	0.383	2.76

* Limited amino acid

proline contents are much lower than wheat flour, this is especially valid for proline. The total contents of 8 essential amino acids of tetraploid have no obvious difference to those of diploid and tatary varieties (Tab. V). Only biological value of protein (the total content of lysine in relation to total protein content) has a reduced tendency, it is also higher than that of wheat flour.

Minerals

The minerals of tetraploid Yuqiao 1 are close to diploid Mudanqiao and tatary Yuqiao 6-21 except the potassium content. Tatary variety 6-21 is rich in manganese and strontium. The main minerals of buckwheat flour are all higher than those of wheat flour (Tab. VI).

V. Total contents of essential amino acids of buckwheat varieties and wheat flour (< CB36)

	Yuqiao 6-21	Mudanqiao	Yuqiao 1	Mean	Meneba
% d.m.	2.41	2.38	2.60	2.46	3.16
% protein	27.56	25.49	24.76	25.94	22.93

VI. Contents of mineral elements of buckwheat and wheat flours (< CB36; µg/100 g d.m.)

Element	Yuqiao 62-1	Mudanqiao	Yuqiao 1	Mean	Meneba
K	4 550	3 570	500	2 873	1 250
Na	1 580	1 630	1 680	1 630	50.0
Ca	313	378	450	380	258
Mg	3 380	3 630	3 900	3 640	300
Cu	4.75	6.50	5.50	5.58	2.88
Zn	24.1	21.50	25.4	23.7	14.8
Fe	58.3	46.5	67.0	57.3	16.3
Mn	9.00	6.50	7.25	7.58	4.63
Co	0.07	0.05	0.06	0.06	0.04
Pb	0.15	0.10	0.13	0.13	0.04
Cd	0.001	0.001	0.001	0.001	0.04
Cr	0.19	0.09	0.13	0.14	0.21
Sr	3.50	0.50	1.75	1.92	0.10
Li	1.00	1.25	1.50	1.25	0.20

VII. Viscograms buckwheat variety and wheat flours (< CB36)

Viscogram	Yuqiao 6-21	Mudanqiao	Yuqiao	1 Meneba
G.T. (C)	62	67	67	63
M.G.R. (BU)	468	675	605	146
R.S.T. (BU)	407	660	570	92
M.R.F.T. (BU)	855	960	760	383

G.T. – gelatinization temperature
M.G.R. – maximum gelatinization resistance
R.S.T. – resistance at stable temperature 90 °C
M.R.F.T. – maximum resistance at falling temperature 30 °C
BU – Brabender units

Viscograms

The gelatinization temperature of tetraploid flour is higher than that of wheat flour, and that of tatary flour is close to wheat flour (Tab. VII). The gelatinization resistance of buckwheat flour is twice as high as that of wheat flour. There is difference in the viscosity curve of buckwheat varieties, the gelatinization resistance of diploid flour is the highest. Thus it can be seen that buckwheat starch has strong water absorption and a high coefficient of expansion, its viscosity and efficient of gelatinization are higher than those of wheat starch.

DISCUSSION AND CONCLUSIONS

The physical and chemical properties of buckwheat kernels and flours were analyzed. The common autotetraploid variety Yuqiao 1 has much larger kernel than its diploid Mudanqiao and tatary variety (Yuqiao 6-21), but the centigrade variance (*CV%*) in single kernel weight of tetraploid also was higher. The different fractions resulting for different produces milling caused different chemical compositions and also different value of nutrition and utilization. There are no obvious differences in protein, amino acids, ash, minerals and crude fiber contents among common diploid and its autotetraploid as well tatary varieties. Buckwheat flour has a relatively higher content of ash, fiber, amino acids, especially the lysine and methionine contents, and minerals than wheat flour. The gelatinization temperature and resistance of buckwheat flour are higher than those of wheat flour.

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Kvalita autotetraploidních nažek pohanky.

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Na vlastnosti pohanky mají nepochybně vliv metody pěstování, přístupnost živin, teplota, vlhkost a další ekologické podmínky. Rozdíl ve výnosu může být důležitým rozlišovacím ukazatelem mezi diploidními a tetraploidními odrůdami pohanky. Zatím nejsou známy podrobnosti o tom, jestli jsou významné rozdíly co do kvality a užitkové hodnoty mezi diploidní a tetraploidní odrůdou, stejně jako mezi diploidními tatarskými odrůdami. V práci byly analyzovány fyzikálně-chemické vlastnosti nažek, krup a mouky pohanky. Obecná autotetraploidní odrůda Yuqiao 1 má mnohem větší nažky než diploidní odrůda Mudanqiao a odrůda pohanky tatarské Mudanqiao 6-21, ale hmotnost tisíce nažek (CV%) byla rovněž vyšší u tetraploidní odrůdy. Různé šarže mouky připravené odlišným způsobem mletí mohou mít různé chemické složení a také jinou výživnou hodnotu a využití. Mezi pohankou jedlou diploidní a tetraploidní nebyly zaznamenány očekávané rozdíly v obsahu proteinů, aminokyselin, popelovin, minerálních látek a hrubého proteinu, ani pokud se jedná o pohanku tatarskou. Pohanková mouka má relativně vyšší obsah popelovin, aminokyselin a minerálních látek než mouka pšeničná. Teplota mazovatění a stabilita těsta pohanky jsou vyšší než u pšeničné mouky odrůdy Meneba.

pohanka; pohanka jedlá (*Fagopyrum esculentum*, Moench); pohanka tatarská (*Fagopyrum tataricum*, L. Gaertn); technologická jakost; nutriční hodnota

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