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The germplasm release of M-62774 and M-62805, two potato clones with cold-sweetening resistance

Leszek Domański[1], *Ewa Zimnoch-Guzowska*[1], *Maria Domańska*[1], *Kazimiera Zgórska*[2], *Małgorzata Paczkowska*[3]

[1] Plant Breeding and Acclimatization Institute (IHAR), Młochów Research Center, 05-831 Młochów, Poland
[2] IHAR, Jadwisin Research Center, 05-140 Serock, Poland
[3] National Food and Nutrition Institute, 61/63 Powsińska, 02-903 Warszawa, Poland
e-mail: mlochow@ihar.edu.pl

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ABSTRACT

Two potato parental lines that have been released by the Plant Breeding and Acclimatization Institute, Młochów Research Center in 2002 are outstanding in cold-sweetening resistance. Both clones M-62774 and M-62805 showed low accumulation of reducing sugars in tubers directly after storage for 4 months at 4°C. They had medium to high yielding ability, satisfactory tuber appearance, increased starch content and high resistance to potato virus Y. M-62774 had light chip colour and good stability of this trait over four years at three storage treatments (8°C, 4°C, 4°C + reconditioning), while M-62805 was capable of producing regularly light coloured chips after storage at: 8°C and at 4°C followed by two-week reconditioning at 19°C. Both clones are male and female fertile and have been successfully used in crossing programme.

INTRODUCTION

The development of improved parental forms and cultivars with low accumulation of reducing sugars after cold storage (4°C) is an important objective of potato breeding programmes both in Europe and in North America (Thill and Peloquin 1995, Mackay et al. 1997, Hayes and Thill 2002). Low content of reducing sugars is related to light colour of fried products (Talburt and Smith 1975). The benefits of processing potatoes into chips or French fries directly from cold storage include elimination of chemicals inhibiting tuber sprouting, less shirinkage, retention of dry matter, decreased disease loss and extended marketability (Thill and Peloquin 1995, Hayes and Thill 2002). The objective of this paper was the characterisation of two potato clones (M-62774, M-62805) developed within the frame of Młochów's parental line breeding programme in respect of their cold chipping ability.

MATERIAL AND METHODS

The pedigree of potato clones M-62774 and M-62805 is presented in Fig. 1.

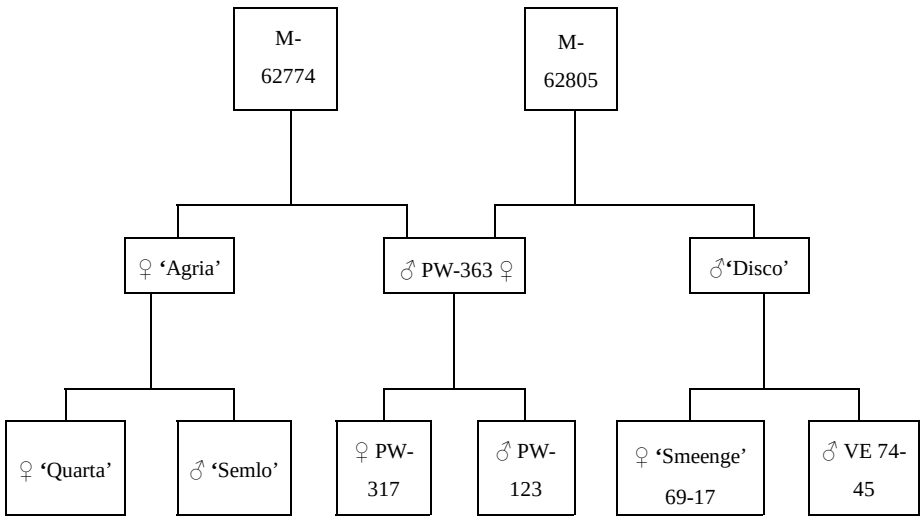

Figure 1. Pedigree of M-62774 and M-62805

Light colour of fry product of these clones was derived from PW-363 and in part from 'Agria' and 'Disco'. Clone PW-363 and 'Agria' in earlier progeny testing

were classified as good general combiners, whereas in the cross combination PW-363 × 'Disco' significant effect of specific combining ability (SCA) for fry colour was observed (Domański et al. 2002). Parental form PW-363, which was used in the development of M-62774 and M-62805 was complex resistant to five viruses: PLRV, PVY, PVX, PVS, PVM.

The potato clones M-62774 and M-62805 were assessed for quality and agronomic traits and disease resistances. The assessment comprised: field trials in 2001 – 2002; chemical analyses for content of reducing sugars in 2000 – 2002, and for content of total dietary fibre in 2002; frying tests in 1999 – 2002; routine tests evaluating the resistance of breeding materials for wart disease, potato cyst nematode (Ro1), late blight, potato virus Y. In 2002, the combining ability for general tuber appearance and tuber shape was assessed in progeny test for two mentioned clones.

Field trials were conducted at the IHAR, Młochów Research Center on non irrigated field in 2001 – 2002. The soil was a loamy sand and was fertilized with nutrients of the following doses (kg ha^{-1}): 110 N, 75 P_2O_5, 165 K_2O, 75 S, 19 MgO. Pest control and other cultural practices were similar to the commercial plantings in the area. Both trials had randomized block design with two replicates and double-row plots of twelve tubers spaced 38 cm between plants and 67.5 between rows.

Traits recorded. Tuber yield was measured at the stage of full maturity (135 days after planting). Starch content was determined with the use of hydrostatic method. Tuber appearance (tuber size, depth of eyes and skin appearance) were evaluated visually with the use of scale 1-9 (9 = the best). The two 30-tubers samples of marketable size (55-75 mm) were taken for determination of the content of reducing sugars and total dietary fibre. Reducing sugars (glucose, fructose) concentration was determined directly after 120-day storage at 4°C and additionally after two week reconditioning at 19°C, using dinitrophenol method (Talburt and Smith 1975). Content of total dietary fibre was determined by enzymatic-gravimetric method (AOAC 1995) in three replications. Chips were produced from the three storage treatments: (1) one-month storage at 8°C – direct fry; (2) three-month storage at 4°C – direct fry; (3) three-month storage at 4°C and two-week reconditioning at 19°C.

Resistance to pathogens of breeding selections was assessed in routine testing of parental lines with the use of procedures given by: Stefan and Malinowska (2000) for resistance to wart disease and *G. rostochiensis*, pathotype Ro1; Chrzanowska and Zagórska (2001) for PVY and PLRV resistance; Zarzycka (2001) for foliage and tuber resistance to late blight.

Progeny test. The progenies originating from crosses between cold-chipping parental lines (M-62724, M-62805) and set of five cultivars ('Albatros', 'Redstar',

'Delikat', 'Oda', 'Snowden') were evaluated for tuber appearance and tuber shape in 2002. Each cross was represented by 120 unselected seedlings grown in the glasshouse.

Statistical analysis. Combined ANOVA for chip colour and estimations of the σ^2_i – the ´stability variance´ (Shukla 1972) measuring genotype's stability over years and storage treatments were carried out. Additionally Dunnett's test was used for comparing the control mean ('Saturna') to each clone mean. Standard error for Dunnett's test was based on mean square of year × genotype variance in case of traits (starch content, reducing sugar content, chip colour) and on error from single factor ANOVA for content of total dietary fibre. All calculations were performed with the use of MSTAT-C software (Michigan University 1991).

RESULTS

General description. Both clones represent the type medium late maturity with fairly vigorous foliage, well covering the soil. Profuse flowering and good fertility of both male and female were observed in case of M-62774 and M-62805. A comparison of various agronomic traits for clones: M-62774, M-62805 and 'Saturna' is presented in Table 1.

Yield. M-62774 and M-62805 were high-yielding clones with quite big tubers (Table 1). Respective yields were 9% and 23% higher than the yield of standard cultivars: 'Mila' and 'Bzura'.

Quality of the yield. Tubers of M-62774 were characterized by high starch content (19.1%) and low incidence of tuber defects like secondary growth or growth cracking. M-62774 had significantly lower concentration of reducing sugars and better chip colour directly after storage of tubers at 4°C than 'Saturna' did (Table 1). Good fry colour and stability of this trait over years was also observed in the remaining chipping treatments. Total dietary fibre in tubers of this clone was on the similar level to that represented by standard 'Saturna', which is commonly processed into chips both in West Europe and in Poland. M-62774 has short-oval tubers with yellow flesh and medium shallow eyes.

Tubers of M-62805 were assessed as oval to long oval, medium to large with shallow eyes and light yellow flesh. The mean starch content of M-62805 was 15.3% as compared with 16.1% for 'Saturna'. M-62805 had significantly higher content of total dietary fibre and better cooking quality (type C) than 'Saturna' did. Tubers of M-62805 were intermediate in reducing sugar content between M-62774 and 'Saturna'. It produced chips scored on similar level to that of 'Saturna' after storage at 8°C or 4°C with reconditioning.

Table 1. Characteristic of parental lines M-62774 and M-62805

Trait	M-62774	M-62805	Control 'Saturna'
Maturity	medium late	medium late	medium late
Tuber yield (t per ha)	40.5	45.7	nt
" " (% of standard cvs:'Mila', 'Bzura')	109.0	123.0	nt
Starch content (%)	19.1 a[1/]	15.3 b	16.1 b
Content of total dietary fibre in peeled tubers (% d.m.)	7.83 b	9.73 a	7.78 b
Content of reducing sugars (% f.m.):			
directly after four-month storage at 4°C	0.08 a	0.23 b	0.33 b
after four-month storage at 4°C and reconditioning	0.05 a	0.04 a	0.05 a
Chip colour (in scale 1-9, 9 = very light colour):			
directly after one-month storage at 8°C	7.2 a	6.9 a	7.2 a
directly after three-month storage at 4°C	6.6 a	5.8 b	5.3 b
after four-month storage at 4°C and reconditioning	7.3 a	6.9 a	6.9 a
Shukla's ´stability variance´ of chip colour (σ^2_i):			
over years and storage treatments	0.38	0.75**	0.09
over years at 8°C	0.08	0.42	0.01
over years at 4°C	0.55	1.83**	0.07
over years at 4°C and reconditioning	0.02	0.36	0.22
Tuber size (in scale 1-9, 9 = the best)	6.8	7.3	6.0
Depth of eyes (" ")	7.0	7.3	6.0
Skin appearance (" ")	6.5	7.0	6.7
Resistances to pathogens:			
wart disease	S	R	R
potato cyst nematode (pathotype Ro1)	S	R	R
potato leafroll virus (PLRV) (in scale 1-9, 9 = resistant)	7.0	4.5	6.5
potato virus Y (PVY) (" ")	8.0	8.0	4.0
late blight – foliage (" ")	4.0	4.0	4.0
late blight – tubers (" ")	4.3	5.5	5.0

[1/] comparable means followed by the same letter are not significantly different (p = 0.05) according to Dunnett's test
** – significantly unstable at p = 0.01
R – resistant, S – susceptible
nt – not tested

Disease resistances. High resistance to common and necrotic strains of PVY and to PLRV is valuable feature of parental line M-62774. M-62774 is susceptible to wart disease and potato cyst nematode and thus it should be crossed exclusively to parental forms resistant to these pathogens. Set of disease resistances of

M-62805 is extended in comparison with M-62774 by resistances to wart disease and potato cyst nematode.

Progeny test. Estimation of the effects of specific combining ability (Table 2) showed that parental combination M-62774 × 'Snowden' and M-62805 × 'Oda' were able to generate (with higher frequency) clones combining round type of tuber shape with good tuber appearance. M-62805 similarly as 'Snowden' was the best at transmitting the round type of tuber shape with good appearance to their offspring.

Table 2. Effects of general (GCA) and specific (SCA) combining ability for the percentage of individuals that were round in tuber shape and possessed good tuber appearance (angular transformation)

Parents	SCA					GCA
	'Albatros'	'Redstar'	'Delikat'	'Oda'	'Snowden'	for female
M-62774	-1.05	0.83	-2.42	-1.43	4.07*	0.47
M-62805	0.95	1.45	-0.45	4.74**	-6.68**	4.45**
GCA for male	-6.11**	-7.78**	-4.19**	3.78**	14.30**	

*- significant at p = 0.05
**- significant at p = 0.01

CONCLUSIONS

The release of M-62774 and M-62805 represents an example of the accumulating multiple resistances and improved quality traits, that is possible with traditional breeding methods. The additional value of clone M-62774 is the low level of reducing sugars directly from cold storage. Such traits are very rarely expressed in chipping cultivars. The valuable feature of both bred clones in comparison with the leading cold-chipping cultivars 'Snowden', 'NorValley' (Novy et al. 1998), and 'Ivory Crisp' (Love et al. 2003) is higher resistance to common and necrotic strains of PVY. The developing of these selections was began 1997. In 2002 they were used in crossing programmes of Polish breeding companies PMHZ Strzekęcin and HZZ Zamarte.

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WYHODOWANIE DWÓCH RODÓW ZIEMNIAKA M-62774 I M-62805 ODPORNYCH NA KONWERSJĘ SKROBI NA CUKRY REDUKUJĄCE W NISKIEJ TEMPERATURZE

Streszczenie: Dwa rody ziemniaka wyróżniające się odpornością na konwersję skrobi na cukry redukujące w niskiej temperaturze zostały wyhodowane w Instytucie Hodowli i Aklimatyzacji Roślin, Oddział Młochów w 2002 roku. Obydwa rody M-62774 i M-62805 charakteryzują się niską akumulacją cukrów redukujących po przechowaniu bulw przez cztery miesiące w 4°C. Ich poziom plonowania oceniono jako średni do wysokiego, obydwa rody wykazują zadowalający wygląd bulw, podwyższoną zawartość skrobi i wysoką odporność na wirusa Y ziemniaka. Ród M-62774 wyróżnił się jasną barwą chipsów i dobrą stabilnością tej cechy przez okres czterech lat, w trzech wariantach przechowywania (8°C, 4°C i 4°C + rekondycjonowanie), podczas gdy ród M-62805 wykazał zdolność do produkcji chipsów o jasnej i stabilnej barwie z wariantów przechowywania 8°C i 4°C z dwutygodniowym rekondycjonowaniem. Obydwa rody są męsko i żeńsko płodne i zostały z powodzeniem wykorzystane w programie krzyżówkowym.

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