Volume 15(1), 21- 28, 2011
JOURNAL of Horticulture, Forestry and Biotechnology

The influence of the dose and rate of chemical fertilizers on culinary quality to *Milenium, gared* and *Nemere* potato varieties

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Abstract Characteristcs and quality play an important role in the production of flakes, chips, french fries both from the point of view of physical and organoleptic characteristics and economic efficiency of the production.
To meet these requirements, potato should have a high dry matter content, the breaking-resistant cell walls should prevent the blackening and after boiling it should have a pleasant taste and aroma.
The acceptance of potato for industrial processing in form of flakes is determined by two factors, mainly by dry matter and starch content.
The experiments took place at the Potato Research and Development Station Targu Secuiesc in the 2010 year.
Our research proposed this approach to the aspects of the influence of the dose and rate of chemical fertilizers on culinary quality to three potato varieties suitable for processing, created at the Potato Research and Development Station Targu Secuiesc.

Key words

potato, variety, fertilization, culinary quality

Among food products, after cereals(wheat, rice ,corn) potato is the most important human nutriment, both in fresh and processed forms.
In EU countries several types of potato dishes are made, like chips, french fries, flakes for mashed potatoes, dehydrated potatoes, canned foods etc., that provide a higher recovery of potato production. In addition, potatoes serve as raw material for starch, glucose, dextrin, oxidized starch, which are either raw material or auxiliary material in industrial production processes like in food, paper, cellulose, chemical, pharmaceutical, building materials, heavy industry, mining industry and others [1].
Processing potato in various forms of prepared and semi-prepared foods means a true revolution in potato production. These processed products, in addition to being nutritious and tasty, make housewives' life easier [3].
In developed countries, more than 28 types of potato dishes are produced (chips, french fries, flakes for mashed potatoes, dehydrated potatoes, canned foods etc.), that provide a higher recovery of potato production. Potato also serves as raw material in the industry, being produced around 40 products: glucose, dextrin, oxidezed starch, which are either raw material or auxiliary material in industrial production processes like in food, paper, cellulose, chemical, pharmaceutical, building materials, heavy industry, mining industry and other industries [4, 5, 6].
In recent decades, potato processing turned to have multitudious utilization mode, developing new potato flake products, selected products by frying (chips) and semi-frying (french fries), by freezing or by canning.
In Romania, the first industrial processing of potato was registered in Transylvania, when the popular ingenuity has discovered the so called „burning mode", that is to say the production of alcohol from potatoes, wherefor small distilleries has appeared.
In recent years started timidly but surely the organization of potato production for consumption and some farmers have specialized in growing certain varieties. It has become a necessity imposed by ecological conditions, market and the fact that sales should be assured by signing contracts between farmers and processing factories. Industrial crop areas are increasing, the demands for farm establishment were higher because of the assured sales [2].

Material and Research Method

Biological material used in the study

NEMERE variety

Nemere potato variety was created at S.C.D.C. Tg. Secuiesc and it was homologated in 2000.

Morphological characters: the sprouts have an oval shape with middle size and red – violet colors on the base of sprouts. The bud of sprout on light is half open and porosity is very dense. The tubers vary in size from medium to large. The leaves have a medium size with a clear green color. The sprouts have large white flowers. Tubers have round –oval shape. Color of skin and pulp is yellow. Stems are erect. Leafs are semi

compact with middle size foliols, green clear. Flowers are white and big.

Figure 1. The *Nemere* variety – potato tubers

Vegetation period: *Nemere* variety belongs to the group of semi-late varieties, with a vegetation period of 80-100 days.

Resistance to diseases and pest: *Nemere* variety is resistant to virus Y and is tolerant to blight (*Phytophthora infestans* (Mont de Bary)).

Culinary quality: it belongs to C class. It is recommended to winter consumption and processing. The starch content is 16-17%.

Yielding capacity: it is a high-yielding potato variety with a yield of over 63.5 tones/ha.

Zoning: *Nemere* variety is recommended for very favorable zones of potato production.

GARED variety

Gared potato variety was created at S.C.D.C Tg. Secuiesc, and homologated in 2004 and certified in 2009.

Morphological characters: the plant is vigorous with a large number of stems and belongs to foliage type. The leaves have a medium size with light – green color. The flowers have a medium size, having a violet color with white points. The tubers have a short oval shape with shallow eyes. The color of skin is red and the color of flesh is cream. The sprouts have a conic shape with middle size and red – violet colors on the base of sprouts. The bud of sprout on light is half open and porosity is dense to very dense.

Vegetation period: *Gared* variety belongs to the group of late varieties, with a vegetation period of over 110 days.

Yielding capacity: it is a high-yielding potato variety with a yield of over 67.0 tones/ha.

Culinary quality: is good and belongs to B class. *Gared* variety is very suitable for pommes frites production. The content of starch is over 21%.

Resistance to diseases and pest: *Gared* variety is resisting to late blight on leaves and tubers, is resisting to leave roll virus (PLRV) and tolerant to virus (PVY). It is resisting to potato cyst nematodes (*Globodera rostochiensis*) and black wart (*Synchitrium endobioticum*).

Figure 2. The *Gared* variety – potato tubers

MILENIUM variety

Milenium potato variety was created at S.C.D.C Tg. Secuiesc, and homologated in 2004 and certified in 2005.

Morphological characters: Tubers have round –oval shape with shallow eyes. Color of skin and pulp is yellow. Stems are tall. Leafs have middle size foliols, green clear. Flowers are white.

Vegetation period: The vegetation period are 100–110 days and this variety belonging to middle late varieties.

Resistance to diseases and pest: it is resistant to PVY and sensitive to late blight (*Phytophthora infestans*). It is resistant to cist nematodes (*Globodera rostochiensis*).

Culinary quality: it has 18.53% starch content and belongs to C group. It is recommended to winter consumption and processing.

Yield capacity; It has a high yield capacity (58.1t/ha).

Figure 3. The *Milenium* variety – potato tubers

Research Methods

Suitability for the chips processing

200 g tubers with skin are taken from each variety as sample. Then the tubers are peeled and weighed again. After that, they are cut crosswise into slices using a grater; these slices are weighed.

Then they are washed several times with warm water, until no further smell of ammonia remains. During the rinsing the slices are slightly separated from each other. They are put in sieve to drain.

It is prepared an oil pan. It is filled with oil up to the mark and when the oil temperature reaches 140°C (red led goes off) the potato slices are put in the hot oil. They are fried until they are cripsy, dried, then they are placed on a paper towel and weighed.

It is also calculated how many chips were produced from a given quantity of potatoes.

Then the color of the chips is evaluated using a standardized scale, in the form of sheets marked from 1 to 9.

Some countries prefer light-colored chips. Chips color is determined by the reducing sugar content; when potatoes are fried, the reducing sugars will caramelize, giving the chips a color. Potatoes with high reducing sugar levels make dark fries.

Chips are weighed, salted and flavored while they are still warm. Chip flavor is evaluated using a scoring scale of 1-4.

Suitability for the french fries processing

1000 g tubers with skin are taken from each variety as sample. Then the tubers are peeled and weighed again. After that, they are cut lenghtwise into batons; these batons are weighed.

It is prepared an oil pan. It is filled with oil up to the mark and when the oil temperature reaches 190°C (red led goes off) the potato batons are put in the hot oil. They are fried for 1-2 minutes, then they are removed from the hot oil, placed on paper towel, drained, cooled and chilled at 4°C for 30 minutes. The freezing process lasts one hout at – 40°C.

After freezing they are packaged in plastic bags and stored at – 18°C. The potato batons are fried in oil at 190°C, depending on preference. The oil consumption is calculated and then how many french fries were produced from a given quantity of potatoes. The cooking time can be noted as well.

French fry flavor is evaluated using a scoring scale of 1-4.

Results and Discussions

By analyzing the variances of the data obtained from the measurements performed on samples of French fries significant differences were pointed out between the varieties tested throughout the whole technological process.

On average the *Milenium* and *Gared* varieties have high cleaning efficiency, over 83%, compared to the *Nemere* variety, which efficiency is 77.5 %; the differences are assured statistically.

The highest yield of French fries obtained from the *Gared* variety (36.6%) it is statistically superior compared to the one obtained from the *Nemere* variety (30.5 %). The *Milenium* variety yield is between the yields of these varieties.

French fries yield differences are related to the starch content of the varieties studied, varieties differing in the same manner. The *Milenium* and *Gared* varieties have an average starch content of 21%, while the *Nemere* variety of 19.2%.

The planting time influenced significantly the starch content, namely it has been recorded a higher average starch content at the late planting time (21.4%), while at the early planting time 19.4%.

Table 1

Effects of the factors studied on the yield on French fries

Specification	Cleaning efficiency	Processing efficiency	Pommes frites yield	Starch
	%	%	%	%
Nemere	77.5 (b)	83.6 (b)	30.5 (b)	19.2 (b)
Gared	83.2 (a)	91.3 (a)	36.3 (a)	20.7 (ab)
Milenium	83.7 (a)	86.9 (ab)	33.1 (ab)	21.3 (a)
Planting time1	80.9	88.2	33.4	19.4
Planting time 2	81.9	86.3	33.2	21.4*
C15:15:15 – 600 kg/ha	82.0	86.1	33.8	20.3
C11:9:20 – 1200 kg/ha	80.9	88.5	32.8	20.5
Ammonium nitrate - 200 kg/ha	81.6	84.8	34.1	19.9
Ammonium nitrate - 300 kg/ha	81.7	89.8	32.9	19.6
Ammonium nitrate - 400 kg/ha	80.7	88.2	33.9	21.1
Ammonium nitrate - 500 kg/ha	81.6	86.3	32.4	20.9
(Duncan test p = 5%)				
Sig. (variety)	0.01	0.10	0.02	0.09
Sig. (planting time)	0.61	0.52	0.92	0.01
Sig. (NPK)	0.60	0.41	0.57	0.84
Sig. (N)	0.98	0.66	0.88	0.50

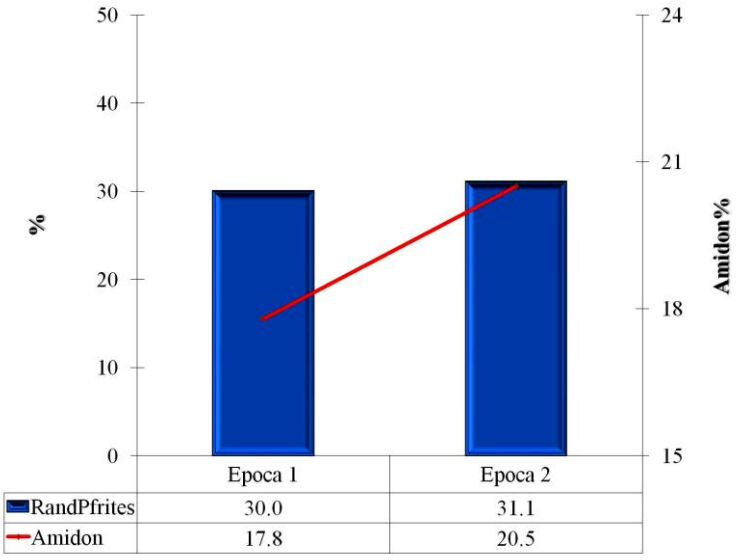

Fig. 1. Effects of the planting time on the yield of French fries in the case of the *Nemere* variety

The planting time influenced significantly the starch content, namely it has been recorded a higher average starch content at the late planting time (20.5%), while at the early planting time 17.8%.

Table 2

Effects of the planting time and the basic NPK fertilization on the yield of French fries in the case of the *Milenium* variety

Specification	Cleaning efficiency		Processing efficiency		Pommes frites yield		Starch content	
	%	± Ab.st.	%	± Ab.st.	%	± Ab.st.	%	± Ab.st.
Planting time I	81,4	3,7	91,4	6,6	32,3	7,4	20,0	1,1
Planting time II	85,9	6,9	82,5	13,5	33,9	5,4	22,6	1,1
C15:15:15 – 600 kg/ha	84,0	5,4	86,4	8,7	32,1	4,9	21,5	1,9
C11:9:20 – 1250 kg/ha	83,3	6,6	87,4	13,9	34,1	7,7	21,1	1,7

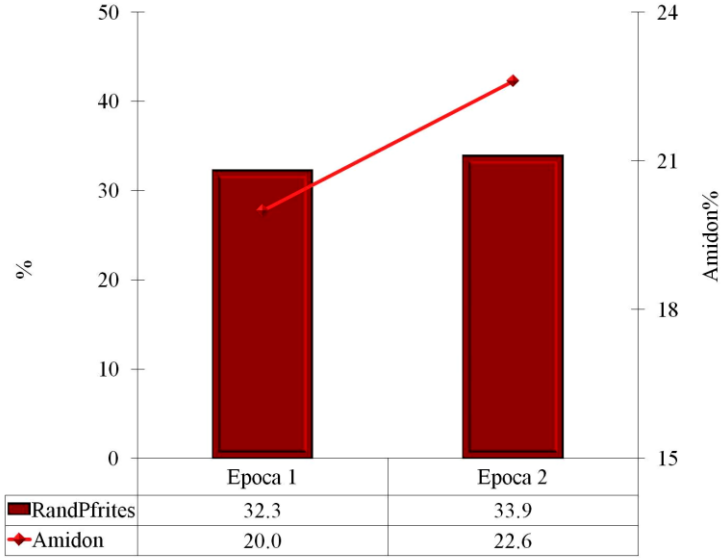

Fig. 2. Effects of the planting time on the yield of French fries in the case of the *Milenium* variety

The planting time influenced significantly the starch content, namely it has been recorded a higher average starch content at the late planting time (22.6%), while at the early planting time 20.0%.

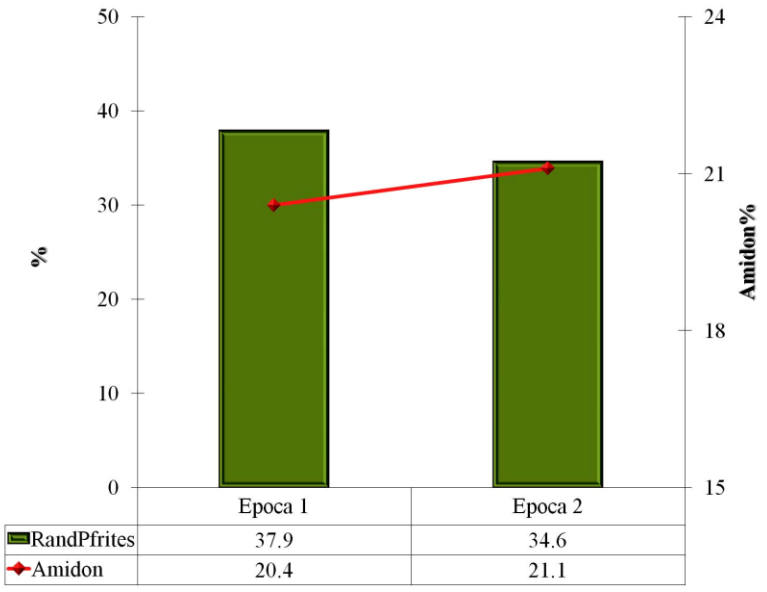

Fig. 3. Effects of the planting time and the basic NPK fertilization on the yield of French fries in the case of the *Gared* variety

The planting time influenced insignificantly the starch content, namely it has been recorded a higher average starch content at the late planting time (21.1%), while at the early planting time 20.4%.

By analyzing the variances of the data obtained during processing of chips significant differences were pointed out between the varieties concerning cleaning efficiency and frying time.

Table 3

Comparison of the average effects of the factors studied on the yield of chips

Specification	Cleaning efficiency (%)	Processing efficiency (%)	Chips efficiency (%)	Time (minute)
Nemere	77.6 (b)	91.7 (a)	26.5 (a)	6.6 (b)
Gared	84.6 (a)	90.5 (a)	29.4 (a)	6.7 (b)
Milenium	81.7 (a)	92.2 (a)	26.7 (a)	7.7 (a)
Planting time1	83.8*	92.4	27.7	7.3
Planting time 2	78.9	0.5	27.4	6.7
C15:15:15 – 600 kg/ha	80.7	91.1	28.4	6.9
C11:9:20 – 1250 kg/ha	81.9	91.7	26.7	7.1
Ammonium nitrate - 200 kg/ha	80.4	91.0	27.7	7.1
Ammonium nitrate - 300 kg/ha	81.6	93.7	28.2	6.8
Ammonium nitrate - 400 kg/ha	80.0	89.8	27.5	7.1
Ammonium nitrate - 500 kg/ha	81.3	91.2	26.8	7.0
(Duncan test p = 5%)				
Sig. (variety)	0.00	0.63	0.12	0.03
Sig. planting time)	0.01	0.19	0.84	0.08
Sig. (NPK)	0.43	0.68	0.19	0.66
Sig. (N)	0.86	0.28	0.91	0.96

According to the Duncan Multiple Comparison on average the *Milenium* and *Gared* varieties have a high cleaning efficiency, namely 81.7% and 84.6 % compared to the *Nemere* variety which has an efficiency of 77.6 %.

The cleaning efficiency of the tubers from the early planting time was high compared to the tubers from the late planting time (83.8% vs.78.9%). Significant differences are also from the point of view of the processing efficiency.

The frying time is significantly longer in the case of tubers from crops planted early (7.3 minutes) compared to tubers from crops planted late (6.7 minutes).

The ammonium nitrate doses between 200 and 500 kg/ha had no significant effect on the suitability for chips.

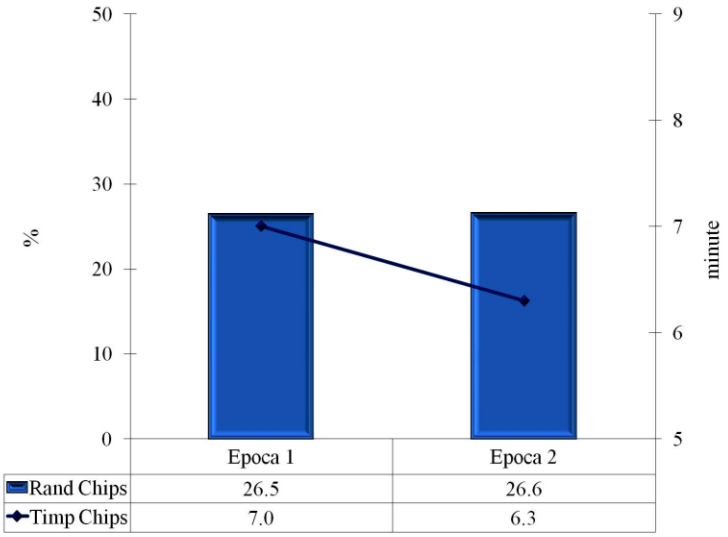

Fig. 4. Effects of the planting time on the yield of chips in the case of the *Nemere* variety

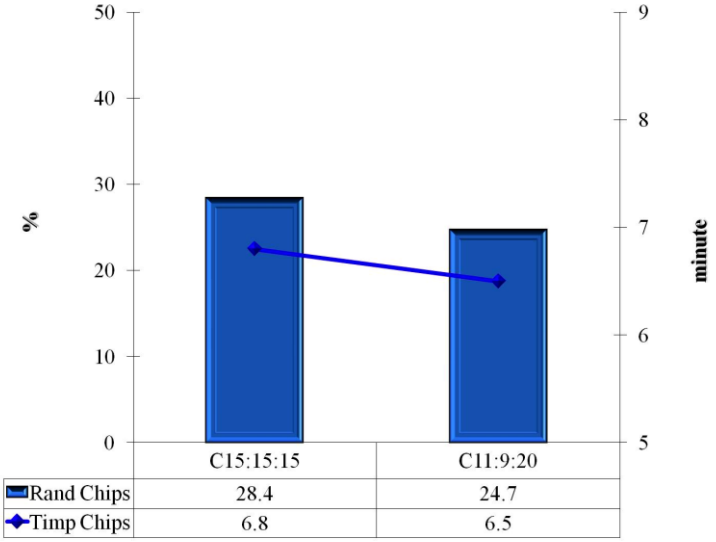

Fig. 5. Effects of basic NPK fertilization on the yield of French fries in the case of the *Nemere* variety

Fertilization with different compound fertilizers had no significant effect on chips yield. In the case of fertilization with 600 kg/ha C15:15:15 the chips yield was 28.4% compared to tubers obtained by using 1250 kg/ha C11:9:20, the differences being statistically not proved.

Conclusions

- By analyzing the variances of the data obtained from the measurements performed on samples of French fries significant differences were pointed out between the varieties tested throughout the whole technological process.
- On average the *Milenium* and *Gared* varieties have high cleaning efficiency, over 83%, compared to the *Nemere* variety, which efficiency is 77.5 %; the differences are assured statistically.
- The highest yield of French fries obtained from the *Gared* variety (36.6%) it is statistically superior compared to the one obtained from the *Nemere* variety (30.5 %). The *Milenium* variety yield is between the yields of these varieties.
- French fries yield differences are related to the starch content of the varieties studied, varieties differing in the same manner. The *Milenium* and *Gared* varieties have an average starch content of 21%, while the *Nemere* variety of 19.2%.
- The planting time influenced significantly the starch content, namely it has been recorded a higher average starch content at the late planting time (21.4%), while at the early planting time 19.4%.
- The planting time influenced significantly the starch content, namely it has been recorded a higher average starch content at the late planting time (20.5%), while at the early planting time 17.8%.
- By analyzing the variances of the data obtained during processing of chips significant differences were pointed out between the varieties concerning cleaning efficiency and frying time.
- According to the Duncan Multiple Comparison on average the *Milenium* and *Gared* varieties have a high cleaning efficiency, namely 81.7% and 84.6 % compared to the *Nemere* variety which has an efficiency of 77.6 %.
- The cleaning efficiency of the tubers from the early planting time was high compared to the tubers from the late planting time (83.8% vs.78.9%). Significant differences are also from the point of view of the processing efficiency.
- The frying time is significantly longer in the case of tubers from crops planted early (7.3 minutes) compared to tubers from crops planted late (6.7 minutes).
- The ammonium nitrate doses between 200 and 500 kg/ha had no significant effect on the suitability for chips.
- Fertilization with different compound fertilizers had no significant effect on chips yield. In the case of fertilization with 600 kg/ha C15:15:15 the chips yield was 28.4% compared to tubers obtained by using 1250 kg/ha C11:9:20, the differences being statistically not proved.

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