Bangladesh J. Bot. **45**(5): 1255-1257, 2016 (December) **- Short communication**

EFFECTS OF MICROWAVE RADIATION ON THE GERMINATION OF *SOLANUM TUBEROSUM* L. TUBERS

TOMASZ JAKUBOWSKI*

University of Agriculture in Krakow, ul. Balicka 116B, 30-149 Kraków, Poland

Key words: Solanum tuberosum, Sprouting, Microwave radiation

Abstract

The aim of this work was to observe germination of potato tubers upon microwave irradiation at various stages of ontogenetic development. Exact experimental and storehouse plots including laboratory testing were carried out in 2011 - 2014. These were related to six various maturity and various purpose edible potato tubers. A generator producing 2.45 GHz microwaves was used for seed-potato irradiation. Microwave radiation of tested potato tubers has an impact on germination.

Proper germination of potato (*Solanum tuberosum* L.) accelerates sprouting, reduces vegetation period and enables earlier harvesting of potato tubers. It also affects enhanced development of a root system, enhanced resistance to the risk of virus infection, decreased range of *Rhizoctonia solani* paralysis, limited mechanical damages and enhanced storing abilities (Delaplace *et al*. 2009, Aladjadjiyan 2010, 2012, Brazinskiene *et. al.* 2014). There is a shortage of relevant information related to the course of germination of potato tubers that would be irradiated with microwaves when exposed directly prior to planting, storing, or in case of the interaction between these two factors in available literature. For cognitive purposes, it is also crucial to determine the response of potato varieties, representing various maturities of crops, to microwave radiation. The aim of this work was to observe germination of potato tubers upon microwave irradiation at various stages of ontogenetic development.

Experimental and storehouse plots including laboratory testing were carried out from 2011-2014 with six edible potato tubers, namely Lord, Owacja, Vineta, Ditta, Finezja and Tajfun. Details of the experimental layout has been presented in Table 1. Each combination included three replications, and for the experimental plot totally randomised configuration was applied. Energy absorbed (induced power) by biological object may be determined through relation after Jakubowski (2011), Barba *et al.* (2008) and described by formula 1.

$$P_B = 2 \cdot \pi \cdot f \cdot \varepsilon_0 \cdot (E_B)^2 \cdot (\frac{m_B}{\rho_B}) \cdot \varepsilon_B'' \qquad (1)$$

Table 1. Experiment layout.

Symbol	Irradiation time/ontogenetic development stage	Assessment of germination
D1	Prior to planting/seed-potato	After storage time
D2	Prior to storing/technically mature tuber	
D3	Prior to planting and storing/technically mature tuber	

*Author for correspondence: < Tomasz.Jakubowski@ur.krakow.pl >.

List of symbols: f - microwave frequency (Hz), ε_0 - permittivity of free space (F/m), ρ_B - potato tuber density (kg/m^3), ε''_B - coefficient of dielectric losses of potato tuber (-), E_B - intensity of electric field generated in the seed potato by microwaves (V/m), m_B - seed potato mass (kg), P_B - power induced in the seed potato (W).

Statistical analysis of the results was carried out with the application of *STATISTICA 10* package at assumed significance level $\alpha = 0.05$. Minimum amount of plants and tubers was determined for the purpose of this work. In the course of determination of the minimum amount, t test for a single trial was applied (on the basis of average population and standard deviation that have been known from pilot studies (Jakubowski 2010abc).

Table 2. Results of variance analysis - effect of potato variety and microwave stimulation time on the number and mass of sprouting.

Independent variables	Value of Wilks test	Value of F-Snedecor test	Value of test probabilisty
Free word	0.0686	1093.072	0.0000
Variety	0.1502	50.877	0.0000
Experiment	0.9052	4.110	0.0029

Table 3. Results of HSD T-Tukey test - effect of potato variety on the number of sprouting.

Variety	Number of sprouts (pcs.)	Homogenous groups					
		1	2	3	4	5	6
Lord	3.44	****					
Lord - control sample	3.12		****				
Owacja	3.06		****				
Owacja - control sample	2.88			****			
Vineta	2.86			****			
Vineta - control sample	2.51				****		
Ditta	2.23					****	
Finezja - control sample	1.97					****	****
Tajfun - control sample	1.92					****	****
Ditta - control sample	1.89						****
Finezja	1.84						****
Tajfun	1.79						****

**** = Homogenous groups.

Shapiro-Wilk and Levenea statistical values were insignificant thus enabled to apply the parameter test in the analysis. Values calculated for variation factor related to potato tuber mass, as a measure for proper selection of the sample, oscillated within range of 9.2 - 17.1%. Microwave unit doses, which have been absorbed by potato tubers, were expressed within the range of 6.2 - 30.8 J/g. The analysis of variance indicated the significance of all assumed grouping variables (Table 2). Effect of statistically significant quality predictors was controlled with post-hoc tests through application of HSD T-Tukey multiple equation procedure. Multiple comparisons, which account for the number (Table 3) of germs derived from a single tuber and their mass (Table 4), confirm that potato sprouting is determined by the alteration that was used in the experiment. A

system of homogeneous groups suggests also that the reaction of a potato (characteristic for germination) to microwave radiation depends on its maturity.

Table 4. Result of HSD T-Tukey test - effect of potato variety on the mass of sprouting.

Variety	Mass of sprouting (g)	Homogenous groups				
		1	2	3	4	5
Lord	0.69	****				
Lord - control sample	0.55		****			
Vineta	0.54		****			
Vineta - control sample	0.50			****		
Owacja	0.49			****		
Owacja – control sample	0.41				****	
Ditta	0.41				****	****
Finezja	0.40				****	****
Tajfun	0.39				****	****
Finezja - control sample	0.33					****
Tajfun – control sample	0.33					****
Ditta - control sample	0.32					****

Microwave radiation showed effects on germination of potato tubers. Results showed increased number of actively sprouting eyes and the mass of sprouting is a subject to the potato variety. From the varieties of potato tubers tested in the present experiment, the Lord tuber showed the biggest microwave impact in the form of increased number of actively sprouting eyes prior to planting and additionally, prior to storing.

References

Aladjadjiyan A 2010. Effect of microwave irradiation on seeds of lentils (*Lens culinaris*, Med.). Romanian J. Biophys. **20**(3): 213-221.

Aladjadjiyan A 2012. Physical factors for plant growth stimulation improve food quality, food production - Approaches, Challenges and Tasks, ISBN 978-953-307-887-8.

Barba A, Calabretti A, d'Amore M, Piccinelli L and Rastrelli L 2008. Phenolic constiuents levels in *cv. Agria* potato under microwave processing. Food Sci. Technol. **41**: 1919-1926.

Brazinskiene V, Asakaviciute R, Miezeliene A, Alencikiene G, Ivanauskas L, Jakstas V, Viskelis P and Razukas A 2014. Effect of farming systems on the yield, quality parameters and sensory properties of conventionally and organically grown potato (*Solanum tuberosum* L.) tubers. Food Chem. **145**: 903-909.

Delaplace P, Fauconnier M, Sergeant K, Dierick J, Oufir M, Wal F, America A, Renaut J, Hausman J and Jardin P 2009. Potato (*Solanum tuberosum* L.) tuber ageing induces changes in the proteome and antioxidants associated with the sprouting pattern. J. Expt. Bot. **60**(4): 1273-1288.

Jakubowski T 2010a. The effect of microwave radiation on the germination process of stored potato tubers. Acta Sci. Pol., Technica Agraria **9**(1-2): 37-44.

Jakubowski T 2010b. The impact of microwave radiation at different frequencies on weight of seed potato germs and crop of potato tubers. Agr. Eng. **6**(124): 57-64.

Jakubowski T 2010c. Effect of seed potatoes microwave stimulation on the growth and yields of potato (*Solanum tuberosum* L.). Acta Agroph. **16**(2): 295-313.

Jakubowski T 2011. Energy absorbed by a microwave irradiated potato tuber. Acta Sci. Pol., Technica Agraria **10**(1-2): 3-13.

(Manuscript received on 29 December, 2016; revised on 6 March, 2016)