

EFFECT OF MONOGLYCERIDE AND LECITHIN ADDITION ON COOKING QUALITY OF PRECOOKED PASTA

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In the paper the results of chosen cooking quality measurements of precooked pasta with emulsifiers addition are presented. The influence of glycerol monostearate and lecithin addition in the amount of 0.25%, 0.5%, 0.75% and 1% of flour weight were tested. The expansion ratio, water absorption, cooking losses, minimal preparation time and sensory assessment of dry and hydrated samples were performed for extrusion-cooked pasta products. The addition of glycerol monostearate (stronger) and lecithin (less) lowered radial expansion ratio and water absorption of the examined pasta as compared to the pasta without any additive. Limited cooking losses were observed for precooked pasta with glycerol monostearate addition. Good quality was confirmed for pasta with the addition of 0.25% glycerol monostearate.

INTRODUCTION

Durum and common wheat pasta may be enriched with technological additives, like emulsifiers, plant oils, plant fibres or fruits and vegetables. These additives can improve the organoleptic value or to give pasta specific tastes or colours [Kruger *et al.*, 1996, Vansevenant, 1996]. The addition of 0.5–1% of emulsifier affects lower pasta stickiness. Emulsifiers can form complexes with starch which have been shown to inhibit swelling, solubilization and enzyme susceptibility of starch [Singh *et al.*, 1998]. Starch granules, especially amylose fractions, are bound into a denatured protein matrix preventing the stickiness of products or cooking losses during cooking [Thomas *et al.*, 1999]. Lecithin, a by-product of the soybean processing industry, has many food and non-food applications. One of its primary uses is to retard amylose retrogradation and prolong the shelf life of baked products [Mohamed *et al.*, 2006]. It was proved that 21% gluten-lecithin/maize starch blends reduced retrogradation by 50%. Lecithin is used in many food products, such as chocolate and confectionery products, margarine, bakery goods and pasta products because of its emulsifying, wetting, colloidal, antioxidant, and physiological properties [Pua *et al.*, 2007]. Addition of 0.5% lecithin significantly improved texture of Cheddar cheese. The texture of such cheese was similar to the texture of the control full-fat cheese. Sipahioglu *et al.* [1999] showed in the report no extrinsic flavour associated with the use of lecithin.

Mono- and diglycerol esters are used in the amount of 0.01–1% instead of soy lecithin, because of its instability and decomposition during long storage. The presence of hydrophilic and lipophilic groups in these emulsifiers provides the

formation of oil-water or water-oil emulsions [Sipahioglu *et al.*, 1999]. During pasta processing the addition of emulsifiers influenced lower springiness and higher plasticity of the dough which provide lower dough adhesiveness to press elements, facilitate dough flow through a chamber and a die, and also lower gluten structure destruction. The addition of mono- and diglycerides at a level of even 2% of flour mass is necessary for pasta designed for freezing or chilling [Kruger *et al.*, 1996]. Its ability to lowering pasta stickiness and water absorption is very useful for precooked pasta applied as the component of ready-to-eat dishes, soups or salads. Azizi *et al.* [2003] tested Iranian wheat bread with the addition of mono-diglyceride (0–0.3%) and lecithin (0–0.6%) and they observed the sensory characteristic depending on the surfactant level. Mono-diglyceride improves crust, upper and bottom surface characteristics of breads but lecithin has an adverse effect on these characteristics. Mono-diglyceride and lecithin improved cavity and porosity of the breads. Lecithin softened the texture of the breads, but the combination of lecithin and mono-diglyceride produced a softer texture. Lecithin addition improved chewing score, but reduced odour, flavour and taste of bread; on the contrary, mono-diglyceride improved these characteristics.

The main subject of the study was to evaluate the effect of chosen emulsifiers' addition on some cooking quality characteristics of precooked pasta products.

MATERIALS AND METHODS

The commercial wheat flour type 500 with high wet gluten content 36.42% (according Polish Standard [PN-91/A-74022] no less than 25%) was used in the experiments. The addition

TABLE 1. Expansion ratio of precooked pasta with addition of emulsifiers.

Emulsifier addition (%)	Radial expansion ratio (-) \pm SD				
	60 rpm	80 rpm	100 rpm	120 rpm	
Without additive	1.55 \pm 0.024	1.60 \pm 0.032	1.74 \pm 0.040	1.83 \pm 0.036	
Lecithin	0.25	1.70 \pm 0.015	1.70 \pm 0.061	1.65 \pm 0.025	1.85 \pm 0.050
	0.50	1.55 \pm 0.010	1.60 \pm 0.045	1.55 \pm 0.036	1.75 \pm 0.025
	0.75	1.42 \pm 0.025	1.42 \pm 0.010	1.48 \pm 0.030	1.55 \pm 0.040
	1.00	1.45 \pm 0.010	1.50 \pm 0.038	1.50 \pm 0.061	1.50 \pm 0.030
Glycerol mono-stearate	0.25	1.55 \pm 0.025	1.65 \pm 0.040	1.65 \pm 0.045	1.65 \pm 0.036
	0.50	1.38 \pm 0.011	1.47 \pm 0.036	1.47 \pm 0.015	1.51 \pm 0.010
	0.75	1.35 \pm 0.015	1.40 \pm 0.015	1.42 \pm 0.029	1.45 \pm 0.025
	1.00	1.31 \pm 0.003	1.45 \pm 0.025	1.45 \pm 0.026	1.45 \pm 0.032

of glycerol monostearate E471 and powder lecithin E322 in the amount of 0.25%, 0.5%, 0.75% and 1% of flour weight was used. For comparison, a recipe without any additives was prepared. The same moisture content of dough (30%) was used. After water addition all compounds were mixed and rested for 0.5 h to equilibrate the moisture content. The precooked pasta was made using the extrusion-cooking technique with an L/D=16/1 single screw extrusion-cooker type TS-45 (ZMCh Gliwice, Poland) with the additional cooling section before the die installed to reduce product temperature and prevent its stickiness. A die with 12 outlets with 0.8 mm in diameter was used. Pasta products were processed at barrel temperature maintained from 95°C to 120°C and extruder screw speed ranging from 60 to 120 rpm. The application of proposed temperature profile connected with the mechanical effect of extrusion-cooked screw speed provided proper starch gelatinization in the pasta products and gave them the properties of a precooked product [Vansevenant, 1996; Thomas *et al.*, 1999]. The last barrel cooling section application enabled lowering product temperature from 120°C inside the barrel to 75-95°C just behind the forming die, which preserved pasta shape and prevented product stickiness [Debbouz *et al.*, 1996]. The capacity of pasta processing using a single screw extrusion-cooker TS-45 varied from 9.6 kg/h at 60 rpm to 24 kg/h at 120 rpm used. After the extrusion-cooking of spaghetti type pasta and conditioning for 4 h at 40°C all products were stored in plastic bags at room temperature.

The achieved precooked pastas were examined for some quality characteristics depending on the process conditions and additives used. The radial expansion ratio of the pasta products was derived from product's diameter divided by extruder die's diameter [Wójtowicz *et al.*, 2002]. The data were obtained in five replications from each extrusion conditions. The water absorption index was evaluated according to the method described by Wójtowicz [2005]. The pasta (10 g) was hydrated in 500 mL of hot water for 10 min, then samples were drained for 10 min and weighed. The WAI was calculated as product weight increase and evaluated as the percent of dry sample weight. Preparation for consumption time was made according to Polish Standard [PN-93/A-74130] using Plexiglas plates to masticate single pasta strain and observe the inside structure after various hydration times in hot wa-

ter [Wójtowicz, 2006a]. Minimal preparing time was noted when a white core disappeared; the test was performed in triplicate. Cooking losses were defining according to the method described by Kim *et al.* [1996] in own modification for precooked products [Wójtowicz, 2004]. 10g of pasta cut into 5 cm long pieces were hydrated in 200 mL of hot water for minimal preparation time under the cover to minimise the evaporation of water. The hydrated-cooked products were rinsed with cold water and drained for 5 min on strainers. Cooking losses were determined by evaporating to dryness the combined cooking and rinses water in Erlenmeyer glass beaker in an air oven at 110°C. The residue was weighed and reported as percentage of dry instant pastas weight before hydration. The measurements were in made triplicate. Sensory assessment of uncooked and hydrated products was performed using 5 points scale according to Polish Standard [PN-A-74131] which includes appearance, colour, aroma of uncooked products and appearance, colour, taste, shape and consistency of hydrated pasta products [Wójtowicz, 2005]. The sensory panel consisted of 15 people trained in the use of the rating method, terminology and sensory characteristics of pasta products.

RESULTS AND DISCUSSION

The expansion ratio is one of the most important factors for instant products, because of the short time hydration for thin-walled products. The experiment demonstrated significantly lower values of radial expansion ratio with increasing the emulsifier addition (Table 1). The addition of lecithin influenced inconsiderable higher expansion ratio with increasing the screw speed used during the extrusion-cooking. Better results were observed for the addition of monoglyceride, which entailed significant lowering of the expansion ratio values as compared to no-additive pasta, especially at high screw speed. Similar relationships were observed by Singh *et al.* [1998] for corn extrudates, namely that the increasing of monoglyceride addition lowered the expansion of products. It may be explained by the ability of monoglycerides to form complexes with starch, the presence of which influenced not only expansion reduction, but also lower starch gelatinization level, lower solubility and water absorption capacity [Singh *et al.*, 1998].

The addition of glycerol monostearate in the amount of 0.5-1% lowered and aligned pasta expansion compared with that without any additive and with 0.25% addition of monoglyceride. Pasta products designed for hydration, not boiling, should be characterised by a small expansion index providing the short preparation time [Vansevenant, 1996]. The expansion index described by Wójtowicz [2002, 2005] for precooked pasta varied from 1.4 to 1.9 depending on dough moisture and screw speed used during the extrusion-cooking process. It was noted that the expansion ratio was lowering with increasing dough moistness. The higher expansion ratio was observed with increasing screw speed. Wang *et al.* [1999] showed a similar tendency for pea pasta, *i.e.* they achieved expansion index from 1.01 with 24% of dough moisture at 100 rpm during processing to 1.69 at the same moisture but screw speed of 150 rpm.

Water absorption of precooked pasta is mostly dependent on the intensity of baro-thermal treatment and degree of starch gelatinization during processing [Wójtowicz, 2005]. Emulsifiers with medium and long hydrocarbon chains inhibit the swelling of starch granules and uptake of water (*i.e.* monoglyceride used in the experiments), binding the amylose by forming organized "crystalline" structures, which inhibits gelatinization of starch up to at least 95°C [Camire *et al.*, 1990]. Water absorption of extrusion-cooked pasta products described by Wójtowicz [2004, 2005, 2006a] varied from 127% for pasta with the addition of egg powder to 360% for pasta processed from wheat flour type 550. The presented results of water absorption measurements varied from 200 to 270% for pasta processed with the addition of monoglyceride and lowered with increasing the additive level (Figure 1). Only for products made at 60 rpm was the influence of monoglyceride addition insignificant.

Lecithin addition also affected the evaluated water absorption of precooked pasta. An escalated content of lecithin from 0.25% to 0.5% was observed to significantly (more than 50%) affect an increase of WAI values, whereas no explicit effect was confirmed for other concentrations used in the recipes (Figure 1). The lowest value was noted for products

processed at a higher screw speed of 120 and 100 rpm, which indicated intensive baro-thermal treatment and a higher level of gelatinised starch. The values reached for these parameters denoted an insignificant influence of lecithin addition on the tested parameter values. The highest absorption of water during hydration was evaluated in the case of products processed at 60 rpm and indicated poor formation of pasta inside the structure able to absorb water, which was confirmed by low notes for consistency of these products. This tendency was also confirmed previously by Wójtowicz [2006b] by the pasta texture profile measurements. The traditional pasta demonstrated water absorption properties at a level of 260% in fresh pasta and 300% in dry pasta [Wang *et al.*, 1999]. The same authors described water absorption of pea pasta at 348% for products dried at low temperature and 294% using the high drying temperature. It shows higher water absorption of pea pasta as compared to commercial products. Abecassis *et al.* [1994] tested semolina pasta and reached the level of absorbed water varying from 168% to 318%. In addition, and a higher absorption ability was observed with a higher moisture content of the dough and a higher screw speed used in the experiments (temp. 35-70°C, extrusion speed 15-30 rpm, semolina moisture content 44-48%).

The minimal preparation time was determined after hydration, not boiling, with hot water. This type of pasta is commonly used in instant soups; the preparation time should not exceed of 5 min hydration or, at least, 2 min of cooking [Kruger *et al.*, 1996]. In the present study the minimal preparation time was evaluated from 5 to 8 min, after that the white unhydrated core disappeared. No significant influence of emulsifier addition was observed on hydration time. This time period was sufficient to achieve a very soft consistency, without any resistance during mastication at bite. Therefore, the minimal preparation time can be shorter (4-5 min), if the consistency *al dente* is preferred (data not shown). In the comparison of precooked pasta without any additives the preparation time appeared to be a little longer (1 or 2 min).

Cooking losses are one of the major factors at determination of pasta functional qualities [Kruger *et al.*, 1996].

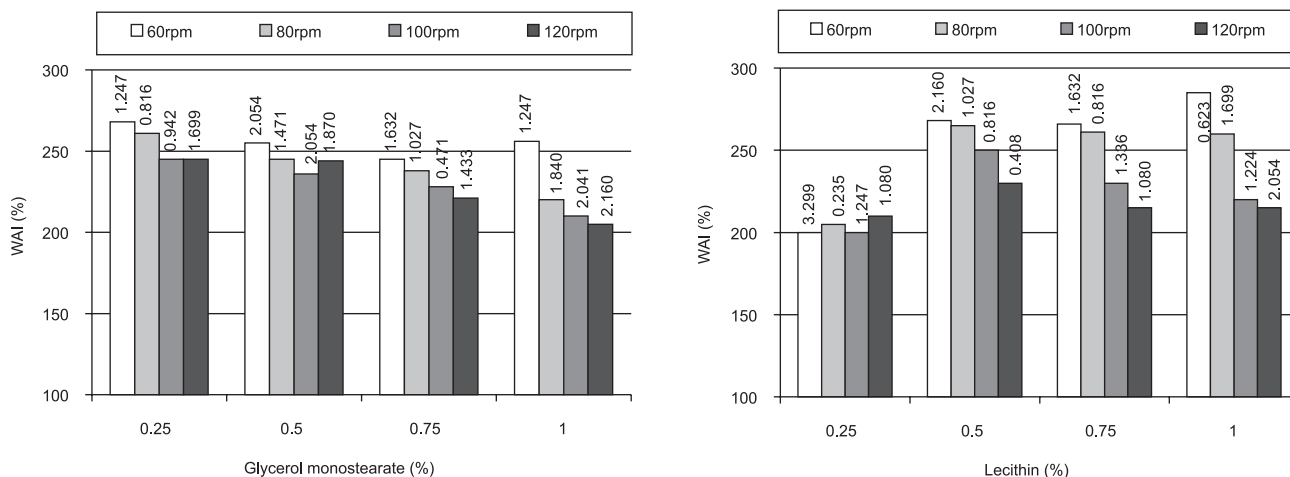


FIGURE 1. Evaluation of water absorption of precooked pasta processed with addition of glycerol monostearate and lecithin (numbers on the graphs are SD values).

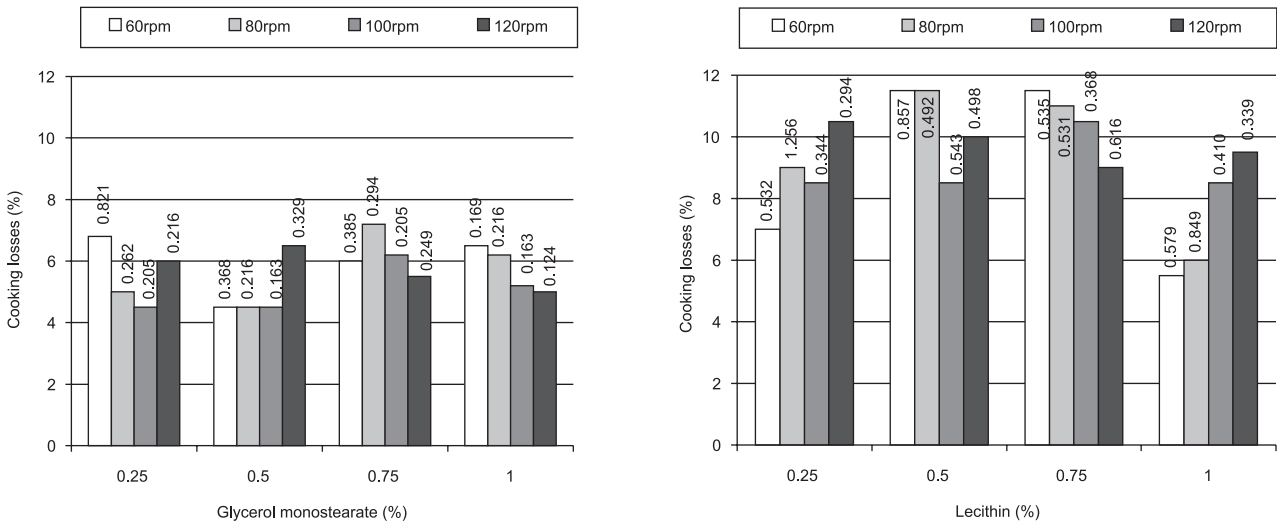


FIGURE 2. Cooking losses during hydration of precooked pasta with addition of emulsifiers (numbers on the graphs are SD values).

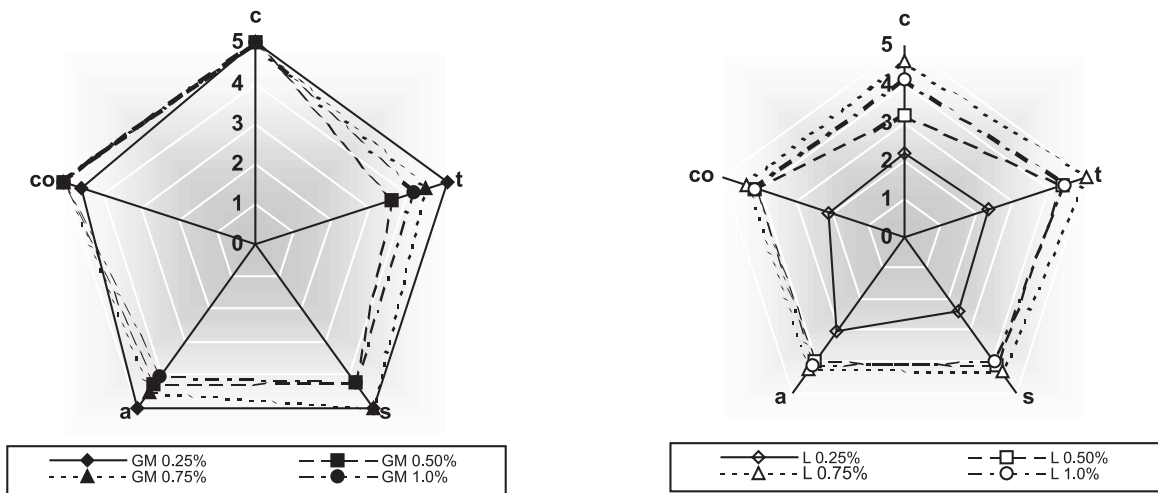


FIGURE 3. Sensory profile of hydrated pasta processed at 100 rpm with addition of (GM) glycerol monostearate and (L) lecithin. (Letters on the graphs: c – colour, t – taste, s – shape, a – appearance, co – consistency).

The inner structure developed under baro-thermal treatment conditions ensures further water penetration of starch and protein substances and prevents its leaching into a solution during pasta hydration [Camire *et al.*, 1990]. This dependence increases as the hydration time prolongs. The cooking losses of instant noodles made from starchy materials other than durum, like soft wheat, rice, maize or legumes, are contained within an interval of up to 10% and it is fully accepted world-wide [Kim *et al.*, 1996]. A similar criterion was adopted in the studies mentioned.

The results of cooking loss measurements are illustrated in Figure 2. There were observed significant differences between values of this parameter in the presence of emulsifier used. The amount of residues during pasta hydration does not exceed 12%, which means a good quality of the reached products. Higher cooking losses were observed when the lecithin addition was used. The acceptable low level of residues was reached only for 1% of lecithin added at every screw

speed used during processing. When glycerol monostearate was added, cooking losses were limited to at least 7%.

Precooked pasta examined by Wójtowicz [2004, 2006a] were characterised by different levels of cooking losses depending on extrusion-cooking parameters and additives used. The high starch gelatinization degree is a major factor influencing the low cooking losses observed during water hydration or boiling [Abecassis *et al.*, 1994; Debbouz *et al.*, 1996; Kim *et al.*, 1996; Kruger *et al.*, 1996]. Semolina precooked pasta processed at a similar conditions with 28-32% of dough moisture and 100-120 rpm used showed 10% or less amount of residues [Wójtowicz, 2006a]. When the lower screw speeds were used, the cooking losses reached even 40-50%. Instant pasta made from various types of wheat flours showed various number of ingredients passing into the water during their preparation for consumption. The main factor affecting changes in the ingredient quantity was screw rotational speed. It was observed that from the pastas made at 60 rpm, irre-

spective of flour type and additives, twice as more substances penetrated into the solution as compared to these processed at 100 rpm. The cooking losses observed for common wheat flours pasta without any additives were around 6–11% [Wójtowicz *et al.*, 2002]. Cooking losses presented by Abecassis *et al.* [1994] for extruded semolina pasta varied from 9.6% to even 51% for products processed at low temperature and screw speed used. Cooking losses of commercial pasta varied from 7.1% for fresh and 7.8% for dry spaghetti in the research presented by Wang *et al.* [1999].

The sensory characteristics of dry pasta products were alike for all examined products with 4-5 scores in the 5-point scale. The best notes were determined for hydrated wheat pasta processed with the addition of 0.25% glycerol monostearate. The mean hydration time was 7 min, after that pasta was soft, not sticky, with a compact and strong consistency. The attributes like colour, taste, shape, appearance and consistency were the highest (4 and 5). The results of sensory profile evaluations of hydrated pasta processed at 100 rpm are illustrated in Figure 3.

The tested pasta products processed at low screw speed (60 rpm) manifested stickiness, floury savour though the short hydration time (7 min) and the notes for appearance were the lowest (from 1 to 2). A higher screw speed improved product's consistency, the floury taste and stickiness disappeared, although the scores were low (mean 3). During processing at 120 rpm the presence of air bubbles inside the strains was observed for pasta with the addition of lecithin, despite the cooling section was involved. When 80 rpm and 100 rpm was applied pasta kept the shape and the appearance was satisfactory. The addition of lecithin in the amount of 0.5%, 0.75% and 1% influenced springiness, firmness and soft consistency with the notes 4. Only for 0.25% lecithin content in the recipe and 60 rpm used were the scores lower (1-2), after 8 min of hot water hydration the pasta was extremely sticky, soaked and disintegrated in water and strong floury taste was present.

CONCLUSIONS

This work has shown the influence of chosen emulsifiers' addition on some quality characteristics of precooked pasta. Extended level of lecithin addition enhanced water absorption and lowered the expansion ratio of pasta as compared to product without any additives. Taking into account results of measurements and sensory assessments the best product was the pasta with the addition of 0.25% glycerol monostearate. The proposed processing profile on single screw TS-45 extrusion-cooker enabled evaluating firm, soft and non-sticky consistency of this product with a palatable taste.

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WPLYW DODATKU MONOGLICERYDU ORAZ LECYTYNY NA WYBRANE CECHY KULINARNE MAKARONÓW PODGOTOWANYCH

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W pracy przedstawiono wyniki pomiarów wybranych cech kulinarnych makaronów podgotowanych wytwarzanych z dodatkiem emulgatorów. Oceniano wpływ dodatku monostearnianu glicerolu oraz lecytyny w ilości 0,25%, 0,5%, 0,75% i 1% masy mąki pszennej. Badaniom poddawano makarony wyprodukowane z zastosowaniem techniki ekstruzji na jednoślismakowym ekstruderze w zakresie temperatur 95-120°C. W wyrobach makaronowych oceniano wskaźnik ekspandowania promieniowego, wodochłonność, straty składników podczas hydratacji w gorącej wodzie, minimalny czas przygotowania do spożycia oraz przeprowadzono ocenę organoleptyczną makaronów surowych i gotowych do spożycia. Dodatek monoglicerydu (istotnie) i lecytyny (nieznacznie) obniżył wskaźnik ekspandowania makaronów (tab. 1) oraz ich wodochłonność (rys. 1) w porównaniu do makaronu wytworzonego bez dodatków. Zaobserwowano mniejszą ilość składników przechodzących do roztworu po hydratacji przy zastosowaniu dodatku monoglicerydu (rys. 2). Najlepszą jakością charakteryzował się makaron z dodatkiem 0,25% monostearnianu glicerolu (rys. 3).