Croatian Journal of Food Science and Technology
journal homepage: www.ptfos.unios.hr/cjfst/

Review paper *DOI: 10.17508/CJFST.2018.10.1.08*

The effect of adding non-conventional ingredients and hydrocolloids to desirable quality attributes of pasta. A Mini Review

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ARTICLE INFO

Article history:
Received: May 2, 2017
Accepted: December 05, 2017

Keywords:
pasta
functional foods
non-conventional ingredients
health benefits

ABSTRACT

As consumption of pasta is becoming more popular especially among the school children, pasta will supply essential nutrition. Moreover, value addition of pasta with different non-conventional ingredients would be helpful in promoting utilization of these with advantage of having several health benefits. Furthermore, the results of this study could provide the industry useful information about potential utilization of different non-conventional ingredients in food formulations and product development for new functional foods.

Introduction

Pasta is most popular and highly convenient food product consumed worldwide. The general term pasta refers to unleavened fresh or dried wheat/semolina dough simply composed of water, flour and sometimes eggs. It is manufactured by blending durum semolina and water to form a homogeneous mixture followed by kneading and finally extruding the mixture into desired shapes and subsequently drying (Aktan and Khan, 1992). *Macaroni*, *spaghetti* and *vermicelli* are different shapes of pasta usually made from durum semolina (*Triticum durum*) which is the best and the most suitable raw material for pasta production due to its unique colour, flavour and cooking quality (Feillet and Dexter, 1998). Generally, common wheat (*Triticum aestivum*) based pasta products have a lower texture quality in comparison with durum wheat. Pasta utilization has increased due to its ease of transportation, handling and cooking preparation (Tudorica et al., 2002). Pasta is a good source of carbohydrates, 74 to 77% (db) and proteins, 11 to 15% (db), but is deficient in lysine and threonin (the first and second limiting amino acids) common to most cereal products (Abdel-Aal and Hucl, 2002). Pasta is considered highly digestible and provides complex carbohydrates, proteins and vitamins. World Health Organization (WHO) and Food and Drug Administration (FDA) consider it a suitable vehicle for incorporation of nutrients (Chillo et al., 2008). Its nutritional quality can be enhanced through addition of non-traditional raw materials rich in fibers (Brennan et al., 2004; Chillo et al., 2008), vitamins and polyunsaturated fatty acids (Iafelice et al., 2008; Verardo et al., 2009).

It was observed that incorporation of non-conventional ingredients into pasta at higher levels does not show better pasta cooking quality characteristics, so there is need of addition of hydrocolloid (Gull et al., 2016b). Generally, hydrocolloids such as carboxy methyl cellulose and guar gum aid in gelling, thickening, water retention and texture improvement (Gallagher et al., 2004) and they can be utilized for the development of healthy pasta products.

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The effect of non-conventional ingredients on functional quality attributes of pasta

Functional properties determine the quality characteristics of pasta including cooked weight, firmness and cooking loss. High quality pasta has a good cooking resistance and firmness and does not release an excessive amount of organic matter into the cooking water.

Cooking loss

The amount of residue in the cooking water is commonly used as an indicator of pasta quality. Low amount of residue indicates high quality pasta. For high quality pasta, the residue should not exceed 7 to 8% of the dry weight of pasta. Krishnan et al. (2010) reported maximum cooking loss of 9.20% in 30% banana flour supplemented pasta. Studies of Islas-Rubio et al. (2014) reported increase in solid loss of pasta with amaranth flour blend addition. Results of Sudha et al. (1998) also reported cooking loss of 8.6% by blending finger millet flour with whole wheat flour up to 50% level. Increase in cooking loss with increase of corn flour substitution with wheat up to 30% in noodles was also found by Ma et al. (2014). Increase in cooking loss of cereal bran enriched pasta, wheat and oat brans enriched pasta was also found by Kaur et al. (2012) and Sudha et al. (2012). Similarly, Foschia et al. (2015) reported increase in cooking losses of glucagel, psyllium and oat substituted pasta. Increase in cooking loss was reported by Gallegos-Infante et al. (2010) in common bean flour added semolina pasta. Cooking loss of 5 to 8.2% was reported by (Sudha and Leelavathi, 2012) in dehydrated green pea flour (DGPF) pasta. Sadeghi and Bhagya (2008) also reported decrease in cooking loss with increase mustard protein isolate supplementation. Badwaik et al. (2012) found increase in percent solid loss with increase in semolina to peanut flour and carrot powder ratio in pasta. However, (Thilagavathi et al., 2016) reported decrease in cooking loss with incorporation of millet and pulse flour to pasta. Increase in solid loss with increase in orange by-product fiber incorporation to pasta was also reported (Crizel et al., 2015). Increase in cooking loss was also found by (Gull et al., 2015a) with incorporation of carrot pomace and millet flour in durum semolina pasta. As reported by (Anna et al., 2014) incorporation of dried grape marc powder did not interfere solid loss properties of pasta after cooking.

Weight gain

Weight gain or cooked weight of pasta indicates gain in weight after cooking and good quality pasta should gain weight three times more than its dry weight. Islas-Rubio et al. (2014) reported decrease in weight gain of pasta samples with amaranth flour blend addition. However, Sudha et al. (1998) revealed that blending finger millet flour with whole wheat flour up to 50% level increased cooked weight more than 3.8 times in vermicelli. Increase in corn flour substitution up to 30% increased cooked weight of fresh noodles (Ma et al., 2014), while Sudha et al. (2012) found decrease in cooked weight of wheat and oat brans enriched pasta. Mirhosseini et al. (2015) reported increase in cooking yield by increasing durian seed flour or pumpkin flour content in the pasta formulation. Results of Borneo and Aguirre, (2008) revealed no difference in weight gain of dried spinach leaves based and control pasta. Sudha and Leelavathi (2012) mentioned cooking weight of 5-8.2% in dehydrated green pea flour pasta. Sadeghi and Bhagya (2008) reported decrease in cooking weight of pasta with increase of supplementation level of mustard protein isolate. Cooked weight of pasta increased with incorporation of millet and pulse flour to pasta (Thilagavathi et al., 2016). Crizel et al. (2015) reported cooked weight of pasta incorporated with orange by-product fiber remained unaffected.

Colour

Colour plays a major role in consumer's perception and acceptability of product. Ma et al. (2014) reported increase in *b** value and decrease in L* value with increase of corn flour substitution up to 30% of fresh noodles. Kaur et al. (2012) found increase in brightness value of cereal bran enriched pasta. Similarly, Foschia et al. (2015) reported colour of raw samples was significantly darker, however after cooking all inulin pasta samples were brighter than durum wheat based pasta. Mirhosseini et al. (2015) reported increase in redness *a** and decrease in lightness L* and yellowness b* values by increasing durian seed flour or pumpkin flour content in the pasta formulation.

The effect of non-traditional ingredients on antioxidant activity and total phenolic content of pasta

Recently, antioxidants have emerged as biomolecules of ultimate interest for human health. These are gaining importance due to their main role as lipid stabilizers and suppressors of excessive oxidation. Polyphenols are diverse class of compounds occurring naturally in a wide range of food plants and these play no role in nutrition (non-nutritious), but have several properties such as anti-cancer , anti-inflammatory etc. Further increase in intake of natural antioxidant rich foods are known to reduce the incidence of degenerative diseases such as cardiovascular diseases and cancer (Perez-Jimenez et al., 2008).

Loncaric et al. (2014) and Yadav and Gupta (2015) reported significantly higher levels of total phenolic content and antioxidant activity in apple peel powder incorporated pasta compared to control pasta. Raw pasta with 15% apple pomace powder showed the highest total phenolic content (TPC) and antioxidant activity (AOA) 1.4g GAE/kg and 0.8mg GAE/100g. Similarly, grape marc incorporated pasta showed higher total phenolic content and antioxidant activity compared to control pasta (Marinelli et al., 2015). Prabhasankar et al. (2009) also reported increase in total phenolic content and antioxidant activity of edible wakame *(Undaria pinnatifida*) seaweed incorporated pasta from 0.10 to 0.94 mg (GAE)/g and 0.16 to 2.14 mg respectively. Similar studies of Khan et al. (2013) revealed that incorporation of red sorghum flour and white sorghum flour at 20, 30 and 40% level to durum wheat semolina showed an increase in total phenolic content and antioxidant capacity at all incorporation levels compared to the control pasta. With addition of common bean flour, total phenolic content and antioxidant capacity were higher than control pasta made from durum wheat Gallegos-Infante et al. (2012). The effect of spirulina biomass substituted at 5, 10 and 20% level to soft wheat flour was studied by De Marco et al. (2014). Results revealed that spirulina incorporated pasta presented high phenolic content and antioxidant activity compared to control pasta. Increase in polyphenol content and antioxidant activity was reported by Ajila et al. (2010); Anna et al. (2014); Crizel et al. (2015) in mango peel incorporated macaroni, grape marc incorporated pasta and orange by-product fiber incorporated pasta. Nithya et al. (2013) also reported increase in antioxidant activity and total phenolic content of rice bran enriched pasta samples. Results of Gull et al. (2016b) also reported increase in phenolic content and antioxidant activity in millet based developed pasta than in control pasta made only from semolina

The effect of non-conventional ingredients on nutritional composition of pasta

Nutrients such as carbohydrates, proteins, fats and minerals are important in the diet of mankind and they are required for growth, survival and health maintenance. Each nutrient is important for particular function in the body constant absence of any nutrient from the diet has a negative impact on health. Proteins in our body carry out many functions such as normal growth and development. Fat is an essential nutrient required in small amounts. It helps in forming and maintaining cell membranes insulate and cushion vital organs. These fats are a concentrated source of energy and minerals are vital for normal functioning of body.

Rathi et al. (2004) found increase in protein, fat, ash and dietary fiber content in pearl millet-based pasta. Reports of Shukla et al. (2014) showed that 50% finger millet incorporated pasta contained highest amount of crude fat 1.15%, total ash 1.40%, crude fiber 1.28%, carbohydrate 78.54%, insoluble dietary fiber 5.45%, soluble dietary fiber 3.71%, iron 5.58% and calcium 88.39% respectively. Similarly, Kulkarni et al. (2012**)** reported high protein, fiber and minerals such as calcium, iron and phosphorous content for noodles developed from malted ragi flour compared to control sample made from semolina only. Ajila et al. (2010) and Crizel et al. (2015) also reported increase in total dietary fiber content from 8.6 to 17.8% and 99% in mango peel powder incorporated macaroni and orange by-product fiber incorporated pasta respectively. Fares et al. (2012) reported increase in dietary fiber of pasta samples enriched with chickpea. Increase in protein, fat, ash and mineral content of noodles supplemented with oat flour was reported by Aydin and Gocmen (2011). Increase in calcium, iron, zinc and dietary fiber content with incorporation of millet and carrot pomace to durum wheat based pasta was observed by (Gull et al., 2016). The results of Madhumitha and Prabhasankar (2011) showed improvement in protein content for black gram substituted durum pasta. Wani et al. (2011) also reported increase in protein, fiber and ash content of noodles substituted with cauliflower leaf powder at 0, 10, 15 and 20 % level than control noodles.

The effect of hydrocolloids on different quality attributes of pasta

Hydrocolloids are high molecular weight polymers generally used in food products as thickeners, stabilizer, gelling agents and emulsifiers. They also improve the texture of products, increase water retention, regulate rheological properties, maintain overall quality of product during storage and participate in chemical transformations (Dickinson, 2003; Juszczak et al., 2004; Takahiro et al., 2005). These can also be used to mimic the viscoelastic properties of gluten thus improving the structure mouth feel, acceptability and shelf life (Chillo et al., 2007).

The United States Food and Drug Administration either consider these compounds as food additives or generally recognized as safe (GRAS) substances. Basic ingredient in most foods is wheat. Hydrocolloids improve granular structure and pasting behavior of starch during cooking or baking of products. When pasta products are made from non-conventional sources, the quality of pasta differs substantially from the pasta manufactured from semolina. In this case, the addition of functional ingredients such as hydrocolloids is necessary. Besides, having neutral taste and aroma also allows their free use in food products. Hydrocolloids are also good source of soluble dietary fiber, thus reduce the concentration of cholesterol and improve gastrointestinal functions and glucose tolerance (Sozer, 2009).

Results of Yadav et al. (2014) reported that with incorporation of carboxy methyl cellulose, improvement in firmness and significant ($p \leq 0.05$) reduction in gruel loss and stickiness were observed in non-wheat based pasta containing pearl millet, barley flour and whey protein concentrate. Similarly, onion substituted pasta enriched with hydrocolloids such as xanthan gum, HPMC (hydroxy propyl methyl cellulose), guar gum, gum arabica and fructo-oligosaccharide showed all quality characteristics comparable to control pasta made from semolina (Rajeswari et al., 2013). Madhumitha and Prabhasankar (2011) found improvement in firmness addition of additives such as gluten and hydroxyl propyl methylcellulose (HPMC) to black gram dhal flour incorporated durum pasta. Decrease in cooking loss, increased cooked weight and firmness of pasta with addition of hydroxyl propyl methylcellulose was noticed by Purnima et al. (2012). Results of Singh et al. (2004) showed that the responses such as solids loss and hardness were most affected by changes in gum levels and to a lesser extent by sweet potato flour and water levels. Sudha and Leelavathi (2012) also revealed that the addition of additives helped in formation of rupture free structure with a continuous network. Overall, it was observed that additives improved the quality of pasta. Ansari et al. (2013) also noticed that when additive such as xanthan gum was incorporated to spaghetti dough, the quality factor and cooked weight were improved significantly and cooking loss reduced noticeably. The results of Padalino et al. (2013) also revealed that addition of hydrocolloids such as carboxy methylcellulose, gellan gum at 2% level improved cooking quality and texture properties (adhesiveness, cooking loss, hardness) of spaghetti. Increase in cooking yield of noodles with addition of guar gum and carboxy methyl cellulose at 1%, 0.5 and 1.0% was observed by Jrnsuwan and Thongngam (2012).

Conclusion

From the present review it can be concluded that addition of non-conventional ingredients to durum wheat semolina showed negative effects on various pasta quality attributes such as cooking loss, cooked weight and firmness on the other hand, they showed increase in antioxidant activity, phenolic content and nutritional profile. However, pasta with better cooking quality attributes can be prepared with addition of hydrocolloids. Thus, it can be concluded that nutritionally rich pasta products, with desirable quality, can be prepared from non-conventional ingredients including. hydrocolloid.

Acknowledgement

The author thanks to Almighty Allah.

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