“FORTIFICATION OF PASTA WITH *CENTELLA ASIATICA*”

The Project presented

To
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Submission Date: 20 December 2018

Letter of Transmittal

Date: 20-12-18

Prof. Dr. Md. Bellal Hossain
Head
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Subject: Fortification of Pasta with *Centella Asiatica*

Dear Sir,

I would like to take this opportunity to thank you for the guidance and support you have provided me during the course of this report. Without your help, this report would have been impossible to complete. With deep gratitude, I also acknowledge the help provided to Professor Dr Md. Bellal Hossain , Professor Daffodil International University many more respective persons, for providing me utmost supervision during my internship in the organization.

To prepare the report , I have been collected what I believe to be most relevant information to make my report as analytical and reliable as possible. I have concentrated my best effort to achieve the objectives of the report and hope that my endeavor will serve the purpose.
The practical knowledge and experience gathered during report preparation will immeasurably help in my future professional life. I request you to excuse me for any mistake that may occur in the report despite of my best effort.
I would really appreciate if you enlighten me with your thoughts and views regarding the report.
Also, if you wish to enquire about an aspect of my report, I would gladly answer your queries.
Thank you again for your support and patiences.

Yours Sincerely,

....

Md. Shoriful islam
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Certificate of Performances

This is to certify that the Internship entitled **“Fortification of Pasta With *Centella Asiatica’’*** Being submitted by Md. Shoriful Islam; ID No: 153-34-459; for the partial fulfillment of degree of Bachelor of Science in Nutrition and Food Engineering, is a record of benefited research work carried out by him under my supervision at the Department of Nutrition and Food Engineering, Daffodil International University, Dhanmondi, Dhaka-1207, Bangladesh . To the best of my knowledge, the work has not been submitted to any other University or Institutes for the award of any other degree.

....
Professor Dr. Md. Bellal Hossain
Head
Department of Nutrition and Food Engineering
Faculty of Allied Health Sciences
Daffodil International University.

Declaration

It is my pleasure to declare that this project Works entitled" **Fortification of Pasta With *Centella Asiatica'"*" is my own original work and an accumulation of my best knowledge and learning on the topic, I feel proud to announce that it contains no material previously published or written by another person no material which has been accepted for the award of any other degree of other university or institute of higher learning, except where due acknowledgment has been made in the text.

....

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ACKNOWLEDGEMENTS

In the preparation of this report, I would like to acknowledge the encouragement and assistance give to me by a number of people. At first, I would like to express my gratitude to my creator the almighty Allah for enabling me the strength and opportunity to complete the report in time successfully. I am grateful to each and every people who are involved with me in every phase of my life.

I am grateful to my parents without whom I cannot be here. Without the support of my parents, I could not be able to achieve my objectives and goals.

My Deep gratitude and sincere thanks to the honorable Dean, Faculty of Allied Health Science, **Professor Dr. Ahmed Ismail Mostafa** for his kind cooperation and to accept this Degree.

I am deeply indebted to my supervisor **Prof. Dr. Md Bellal Hossain**, Head of Department of Nutrition & Food Engineering, Daffodil International University for his whole-hearted supervision. He tirelessly provided me teaching, guidance, comments, and direction as I learned my way through this process. His willingness to take on an engineer to train in food science, gave me a chance to pursue a field that I have and will continue to truly love. I would also like to thank my committee members, **Ms. Najia Kamrul** and **Ms. Effat Ara Jahan**, for their guidance and assistance. I am grateful for your contributions to my work.

I would like to thank Md Amdad Hoshen for his guidance in NFE lab in instructing me how to operate and understand the Texture Analyzer, statistical analysis. Additionally, many thanks go out to Md Elahi Hosen for their endless administrative assistance throughout my graduate career.

Special thanks to my lab mates, Amanot Ullah, Hasibur Rahman, Sohag hosain, and Razib ,

for their company and assistance.

Dedicated

To

My Parents

ABSTRACT

Pasta is a popular food in many cultures, and its simple ingredient list and ease of preparation make it a quick food option for people around the globe. Pasta sample was fortified with 30% ***Centella asiatica*** **paste** with flours and evaluated against a control made of 100% Semolina flour for cooking quality, texture, color, proximate analysis, and consumer acceptance under sensory Evaluation . Pasta products containing ***Centella asiatica*** is a new great look in color Green than Market Macaroni Pasta. Cooking loss of fortified pastas was significantly Green color than raw product and market product was still yellow. Hardness and Adhesiveness of the pasta Noodles increased as the percentage of fortification increased and Cohesiveness was moderately affected during physical (Based on kinetics) test. 30% value added Pasta was found to have the lowest firmness(Eating), as well as having the least acceptability in sensory testing. Pasta was Green with bright in color, the increased addition of *Centella asiatica* paste. Semolina flour supplementation was found to increase protein, fat, fiber, and ash, content of pasta. All sensory characteristics of pasta variations were deemed acceptable in the sensory study. Pasta had the highest protein content , while maintaining the most overall acceptable color, texture, and sensory scores in comparison with Market control product.

The proximate value of the developed pasta was Moisture-12%, Protein-36%, Fat-0.29%, Ash- 1.7%, Dietary Fiber-1.3, Carbohydrate-76, Gross energy

The sensory analysis value are 20 person result was sample like extremely-2, like very much 7, like moderate 8, like slightly 2 dislike slightly 1,Dislike very much 0 Dislike extremely 0.

At this period , maximum population in the village levels are going to added the newly incoming Pasta Noodles into their every days snacks to overcome time shortage . This products are to be considered in our snacks due to fortification of value added vegetables or Herbs.

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CHAPTER 1

INTRODUCTION

Pasta is a popular food in many cultures, and its simple ingredient list and ease of preparation make it a quick food option for people around the globe. As a wheat-derived staple food with a very long shelf life, it is second only to bread in world consumption (Mariani-Constantini 1988, Madhumitha 2011). The highest quality pasta is made solely from durum wheat semolina flour. This creates a product that has great rheological properties, cooking quality, and high consumer acceptance (Dexter and Matsuo 1979). Semolina flour, however, has a limited nutritional profile and is lacking in the amino acids lysine and threonine (Kies and Fox 1970, Abdel-Aal and Hucl 2002, Zhao and others 2005).

High protein diets are presently very popular and highly acceptable among health conscious consumers trying to watch their calorie intake, increase satiety, and lose weight. *Centella asiatica* that have been gaining a lot of recognition in the market for their high quality nutritional profile. *Centella asiatica* are legumes that contain a large quantity of high quality fiber, along with a flour contain good balance of amino acids (Sabanis and others 2006). Quinoa, a pseudo-cereal, is rich in histidine and lysine, amino acids that traditional semolina flour lack (Mastromatteo and others 2011). Both of these foodstuffs can be milled and used to replace or fortify typical durum wheat flour.

Fortification of foods has been used by the food industry for years and continues to be beneficial in providing consumers with added nutrition. The World Health Organization (WHO) and the United States Food and Drug Administration (FDA) consider pasta to be a good product for nutritional improvement due to its low levels of protein and fiber (Marconi and Carcea 2001). In 1949, the FDA made pasta one of the first foods to permit vitamin and iron enrichment allowing pasta manufacturers the ability to fortify their products with added nourishment (FDA 1999). Legume and pseudo-cereal flours are a new frontier that many companies are turning to for added fortification. Much research has been done on fortifying and supplementing pasta with different combinations of non-traditional flours, such as green pea, yellow pea, chickpea, and lentil flours (Zhao and others 2005), amaranth flour (Chillo and others 2008a), split pea and faba bean flours (Petitot and others 2010a), and quinoa, oat, and broad bean flours (Mastromatteo and others 2012). Studies have also been done on the effects of adding solely chickpea flour (Wood 2009) and quinoa flour (Lorenz and others 1993) to pasta; however, no studies have been identified using *Centella asiatica* to fortify semolina pasta.

The objective of this research is to formulate a pasta product with increased levels of fiber and phytonutrients with protein and an improved amino acid profile by adding *Centella asiatica* paste to traditional durum wheat semolina. The effects of fortification on texture, color, cooking quality, and consumer acceptance are to be analyzed, and the most desirable ratio of *Centella asiatica* is to be determined. The most desirable ratio is expected to be either 15% and 30% where the deficient paste are all increased without negatively affecting quality.

LITERATURE REVIEW

2.1 Pasta

2.1 Overview

Due to its low price, ease of preparation, stable shelf life, and overall versatility, pasta is consumed by many people worldwide. Having originated in Asia and the Mediterranean, Italy is still most well-known for its pasta making and leads in national consumer consumption per capita (International Pasta Organization 2011). Setting a standard in innovation, Italian pasta makers formed trade associations by the 16th century. These organizations regulated the industry by requiring things such as special license to produce pasta made from anything other than durum wheat (Kill 2001a). This highly regulated nation has set the benchmark for quality and preparation everywhere.

The versatility of pasta allows it to be formed into almost any shape and size. It comes in varieties such as spaghetti, fettuccine, macaroni, rotini, and farfalle. It can even be stuffed with meats or cheeses to make ravioli. Pasta is prepared in two styles, fresh or dried. Fresh pasta eliminates the drying step and allows for a much quicker product to be made, but has only a portion of the shelf life of dried pasta.

According to R. C. Kill (2001a), creating good quality pasta relies on three crucial factors: raw material, mixing and production, and drying. Since basic pasta is made using flour and water, the use of quality flour is essential, hence, the strong preference to durum wheat. Another common variation of pasta is egg noodles. Adding egg increases nutritional value, changes mouth-feel, and makes for a stronger noodle (Kill 2001b).

Another frequent practice in pasta making is altering the color from its traditional yellow to red or green. This is done by adding powdered spinach or tomato to the flour before hydrating (Kill 2001b).

The mixing process in pasta making is essential for protein binding and gluten matrix formation. In this step, water is added to the dry ingredients to achieve a dough with moisture content of 30-32% (Dintheer 2001). There are three approaches to forming and extruding the pasta dough. The approach used most often at-home and in small scale pasta production utilizes a batch mixer and hand-held extruder. In this process, the dough is formed by hand or in a small mixer, and then run through the extruder. A semi-continuous approach requires first mixing the flour and water into a crumbly dough mass before being homogenized by screw presses and then extruded (Dintheer 2001). The last approach, most often utilized by industrial pasta manufacturers, is continuous mixing/kneading where flour and water are added directly to the twin-screw extruder and homogenized right before being extruded (Dintheer 2001). The temperature, moisture content, and pressure are all important parameters of pasta production and have a direct effect on pasta quality (Dintheer 2001). In commercial pasta production, these parameters have been carefully established and are closely monitored.

The third critical aspect of creating quality pasta is drying. Studies have shown that the drying of pasta is very important to the structure and stability of pasta, and when dried, the moisture content is similar to that of the original material (Kill 2001a). It is important to note that although the pasta drying process is important to pasta quality, it is not the focus of this research and will not be further discussed.

2. 2 Durum Wheat

For centuries, durum wheat has been the preferred flour source for both commercial and at-home pasta making. Typical bread wheat, or common wheat, lacks the hardness, gluten quality, and yellow color that durum wheat boasts for excellent pasta products (Kill 2001a). Both durum wheat, or *Triticum durum*, and common wheat, or *Triticum aestivum*, are members of the genus *Triticum*, home to all wild and cultivated wheat (Wiseman 2001). These wheat are cereals and a part of the large grass family, *Gramineae [Poaceae]*. Durum wheat is rarer than common wheat, and can be grown in only certain parts of the world (Kill 2001a). While common wheat can adapt to a wide range of environments, durum wheat thrives in semi-arid climates, having 55-60% of its crops grown in the Mediterranean region (Kill 2001a, Wiseman 2001). Common wheat is easily milled and has a starchy, floury endosperm, making it ideal for use in breads (Wiseman 2001). Durum wheat, on the other hand, has a particularly hard endosperm, resulting in a coarse yellow milled product containing very few fine flour particles (Wiseman 2001). This milled product is called semolina.

Wheat kernels are made up of three main parts: the bran, endosperm, and germ. The bran is the outer coating of the wheat kernel and protects the endosperm and germ. It makes up approximately 13% of the kernel. The germ is the smallest part of the kernel, comprising only about 3% of its weight. It is home to the developing plant or embryo. The starchy endosperm is the storage site of food for the plant and home to most of its proteins. It is the largest component of the wheat kernel, making up approximately 82% of its weight (Orth and Shellenberger 1988). Figure 2.1 illustrates the different parts of the wheat kernel.

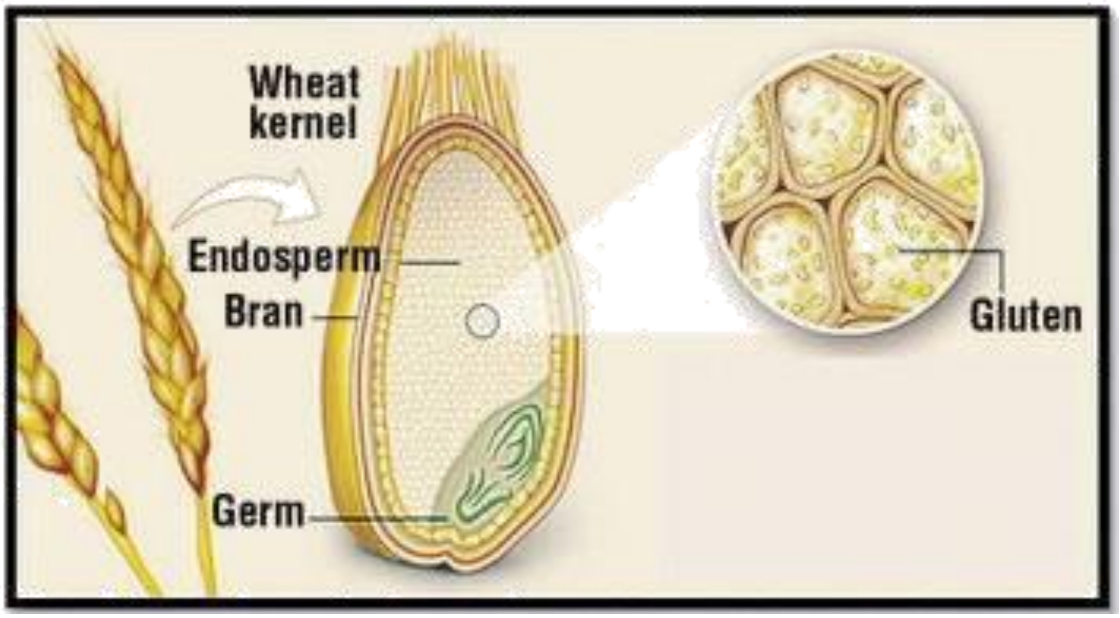


Figure 1.1 Diagram of wheat kernel (Hill 2012)

Milling is the multi-step process where the wheat kernel is broken up and the endosperm is separated from the bran and germ, resulting in wheat flour. Semolina flour has an amber color compared to common flour because of the carotenoid pigments in the endosperm (Donnelly 1991). Table 1.1 shows the nutritional values of semolina flour and bread wheat flour.

Table 1.1 Nutritional comparison of semolina and bread wheat flour (USDA 2013)

	Semolina	***Bread Wheat***
	(Value per 100g)	
Water	12.67 g	13.36 g
Energy	360 kcal	361 kcal
Protein	12.68 g	11.98 g
Total lipid (fat)	1.05 g	1.66 g
Ash	0.77 g	0.47 g
*Carbohydrates**	72.83 g	72.53 g

Table 1.1 (continued) Nutritional comparison of semolina and bread wheat flour (USDA 2013)

Minerals	***Semolina***	***Bread Wheat***
	(Value per 100g)	
Calcium, Ca	17 mg	15 mg
Iron, Fe	1.23 mg	0.9 mg
Magnesium, Mg	47 mg	25 mg
Phosphorus, P	136 mg	97 mg
Potassium, K	186 mg	100 mg
Sodium, Na	1 mg	2 mg
Zinc, Zn	1.05 mg	0.85 mg

*found by difference

2. 3 Wheat Protein Complex

The two key components in pasta manufacturing are the gluten proteins and starch (Johnston 2001). Wheat consists of both soluble and insoluble protein fractions. Albumin and globulin are soluble proteins and are found mostly in the germ and bran of the kernel. The insoluble protein fractions, gliadin and glutenin, are found in the endosperm and make up approximately 85-90% of the protein fractions (Swanson 2007). Together, gliadins and glutenins form gluten. This protein complex “described as a cohesive, elastic and extensible fibrillar network covered with a protein membrane” (Swanson 2007) is responsible for maintaining the structure of wheat products, such as bread and pasta. Gliadins are necessary for the elasticity of gluten. They are single-chained molecules distinguished by their intramolecular disulfide bonding which form compact globular molecules. Glutenins are responsible for providing strength and cohesion of the wheat gluten complex. They are characterized by intermolecular disulfide bonding making them large, multi-chained molecules, containing many exposed functional groups (Swanson 2007).

In the pasta making process, water is added to flour, hydrating the grains and forming hydrogen bonds between the water and protein molecules. This hydration combined with mechanical manipulation (or kneading), causes the gliadin and glutenin proteins to unfold and align, forming gluten (Swanson 2007). The gliadin and glutenin protein structures can be seen in Figure 1.2.

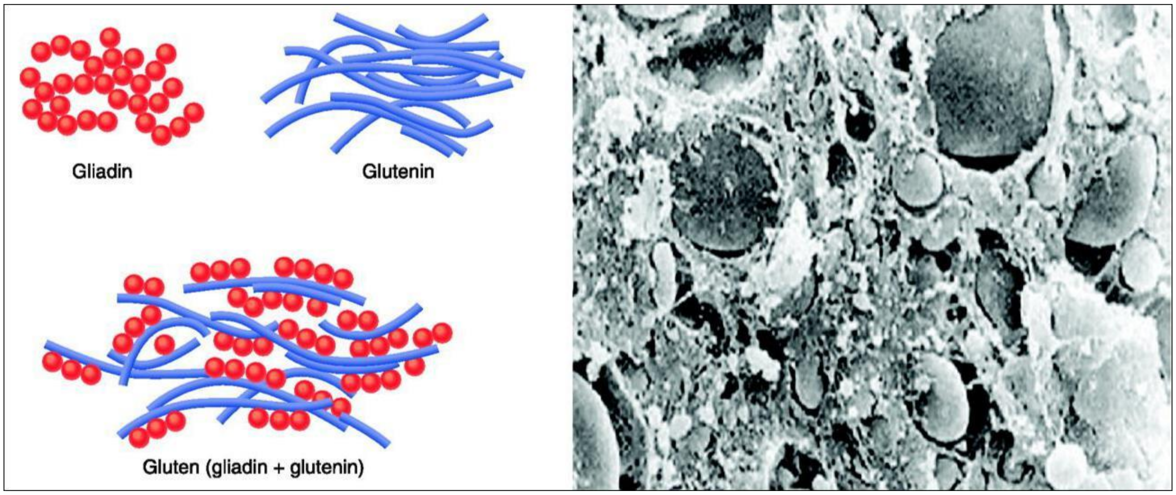


Figure 1.2 Illustration of gliadin and glutenin protein structures (left) Scanning electron microscope image of structural interaction of proteins (right) (Fasano 2011)

Protein content and quality of flour are both important factors in gluten formation. The greater amount of protein present, the stronger the gluten structure will be formed. However, if pasta contains too high a protein content, particularly gliadin and glutenin, then the yielded product is reported to stretch too much during extrusion (Dick and Matsuo 1988). Donnelly (1991) determined that flour with a minimum of 36% protein is needed to produce a good quality pasta. Durum wheat falls in the medium protein range with that which is commercially available containing 9-18% protein.

The protein matrix is crucial to the formation of pasta. If it is disrupted by other additives, it will negatively affect cooking quality leading to a decreased optimum cooking time (Chillo and others 2007, Chillo and others 2008b) and a higher cooking loss (Ugarcic-Hardi and others 2003, Sabanis and others 2006). Gluten "contributes to the development of a strong protein network that prevents the dissolution of pasta during cooking" (Marconi and Carcea 2001). When pasta is cooked, an insoluble network of proteins is formed that entraps swollen and gelatinized starch granules (Smewing 1997). If less protein surrounds the starch granules, they swell and gelatinize faster, lowering the cooking time (Grzybowski and Donnelly 1977). If this network is weakened by too great of an addition, then the integrity of the pasta is compromised and the structure is weakened. Sabanis and others (2006) and Wood (2009) found that substituting non-gluten containing flours for greater than 30% of wheat flour negatively affected the protein matrix, creating pasta products that were difficult to extrude and overall unacceptable.

2.4 Nutritional benefits

On its own, the nutritional content of pasta is similar to that of semolina flour. In a review by Douglass and Matthews (1982), researchers compared the nutrient content of semolina flour and macaroni as a percent concentration of durum wheat, and found that the greatest change in nutritional content from processing occurs when durum wheat is milled into semolina flour. From this study, it can be seen that the processing of pasta does not adversely affect the nutritional content of semolina flour, but rather, pasta products remain closely similar to that of the flour used. Compared to durum wheat, the semolina and macaroni tested maintained most of the original protein, but lost almost

50% of both fat and ash (Douglass and Matthews 1982). Since semolina flour is limited in amino acids, such as lysine and threonine (Kies and Fox 1970, Abdel-Aal and Hucl

2002, Zhao and others 2005), it is understood that pasta is also deficient in these compounds.

Although pasta contains some nutritional content, it is rarely eaten on its own due to its simple lack of flavor. This is why it is typically used as a base to meals and served with sauces or other toppings.

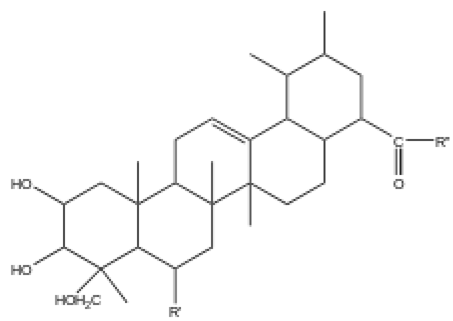
2.5 Centella asiatica

Centella grows in temperate and tropical swampy areas in many world regions. The stems are slender, creeping stolons, green to reddish-green in color, connecting plants to each other. It has long-stalked, green, rounded apices which have smooth texture with palmately netted veins. The leaves are borne on pericladial petioles, around 2 cm (0.79 in). The rootstock consists of rhizomes, growing vertically down. They are creamish in color and covered with root hairs.

Figure 1.3 : Centella asiatica leaf

The flowers are white or pinkish to red in color, born in small, rounded bunches (umbels) near the surface of the soil. Each flower is partly enclosed in two green bracts. The hermaphrodite flowers are minute in size, less than 3 mm (0.12 in), with five to six corolla lobes per flower. Each flower bears five stamens and two styles. The fruit are densely reticulate, distinguishing it from species of Hydrocotyle which have smooth, ribbed or warty fruit. The crop matures in three months, and the whole plant, including the roots, is harvested manually. It is a highly invasive plant, rated as "high risk". Centella has numerous common names in its regions of distribution.

Chemistry



Triterpene compounds of *Centella asiatica*

Centella contains pentacyclic triterpenoids, including asiaticoside, brahmoside, asiatic acid, and brahmic acid (madecassic acid). Other constituents include centellose, centelloside, and madecassoside.

CHAPTER 2

MATERIALS AND METHODS

3.1 Pasta preparation

Samples of semolina (Lot 255504), Centella asiatica flours were received from ConAgra Mills (Omaha, NE), kept in original packaging, and stored in air-tight containers until use. Pasta samples were produced by hand in a homemade style. The control sample (CTRL) was made of 100% semolina flour, while two variety of sample with Centella asiatica paste. The ratios consisted of 15% Centella asiatica with flour and 30% Centella asiatica with flour (30:70 CQ)

The pasta formulations are shown in Table 3.1.

Table 3.1 Pasta formulations

Formula	*Semolina flour (g)*	Centella asiatica *(g)*	*Egg pcs*	*Water (mL)*
15:85 CQ	255.0	45	2	80.0
30:70 CQ	240.0	90	2.0	80.0
CTRL	90.0	0.0	1.0	40.0

The dry ingredients were combined into a homogenous mixture and poured onto a clean, smooth work area. Warm water at approximately 32-49° Celsius was slowly poured into a well formed in the center of the mounded flour.

Materials and ingredients :

- Centella asiatica paste
- Semolina Flour
- Water
- Salt
- Eggs albumin
- Weight balance
- Blender machine
- Dough Mixer
- Dough sheeter
- Pasta shape dies
- Tray
- Solar dryer or electric dryer
- Air seal packet

Methods and Process steps :

There are two steps used for analysis

- Making Pasta (raw product)
- Cooking steps (serving or tasting)

Pasta making process and procedure

First of arrange all ingredients on table

(a) Make Centella asiatica paste though Blender machine
(b) Mix all ingredients in Dough Mixer

I maintain two various sample by used different ratio Centella asiatica paste that was 25% and 30% but other ingredients ware same.

(c) Rest dough half an hour (30 m)
(d) Make Dough sheet by Dough sheeter
(e) Hand made shape pasta size and shape.
(f) Solar dryer use for drying pasta its was 7.30 Hours
(g) Cooling and Air seal packet
(h) And storage

Flowchart

All Ingredients

Make dough

Pasta shape (cut)

drying

Pasta Cooking steps (serving or tasting):

(a) Boiling pasta into hot water at 10-15 minutes.(105^0C)

(b) Remove pasta from hot water and wash though cold water

(c) Fry pasta with vegetable and spices

(d) Tast or serve (sensory evaluation)

(e) Accepted results and conclusions

Figure 3.1: Pre paste process picture

Figure 3.2: Dough preparation set

Figure : Dough mixture and rest time process image

Pasta Cooking Flowchart

Boiling pasta into hot water at 10-15 minutes.(105^{0}C)

↓

Remove pasta from hot water and wash though cold water

↓

Fry pasta with vegetable and spices

↓

Tast or serve (sensory evaluation)

↓

Accepted results and conclusions

CHAPTER 3

RESULTS AND DISCUSSION

4.1 Pasta preparation

When making the pasta products, it was observed that the dough of formula 15% and 30% ***Centella asiatica*** was dry paste to work with. There was a lot of cracking along the edges of the pasta sheets as the dough was being thinned, and although those elements were not used, when cooked, the pasta strands broke apart easily, resulting in much shorter pasta noodles than anticipated. The pastas containing a greater ratio of ***Centella asiatica*** and flour, such as 30:70 CQ and 15:85 CA, were fairly moist and easily formed a dough. Extra care had to be taken, however, when the more moist dough was run through the pasta maker due to its tendency to stick to the rollers. The control pasta was the moistest and the easiest to form into a dough. During processing, it was extremely smooth with no cracking or sticking. Prepared pasta samples can be seen in Figure 4.1.

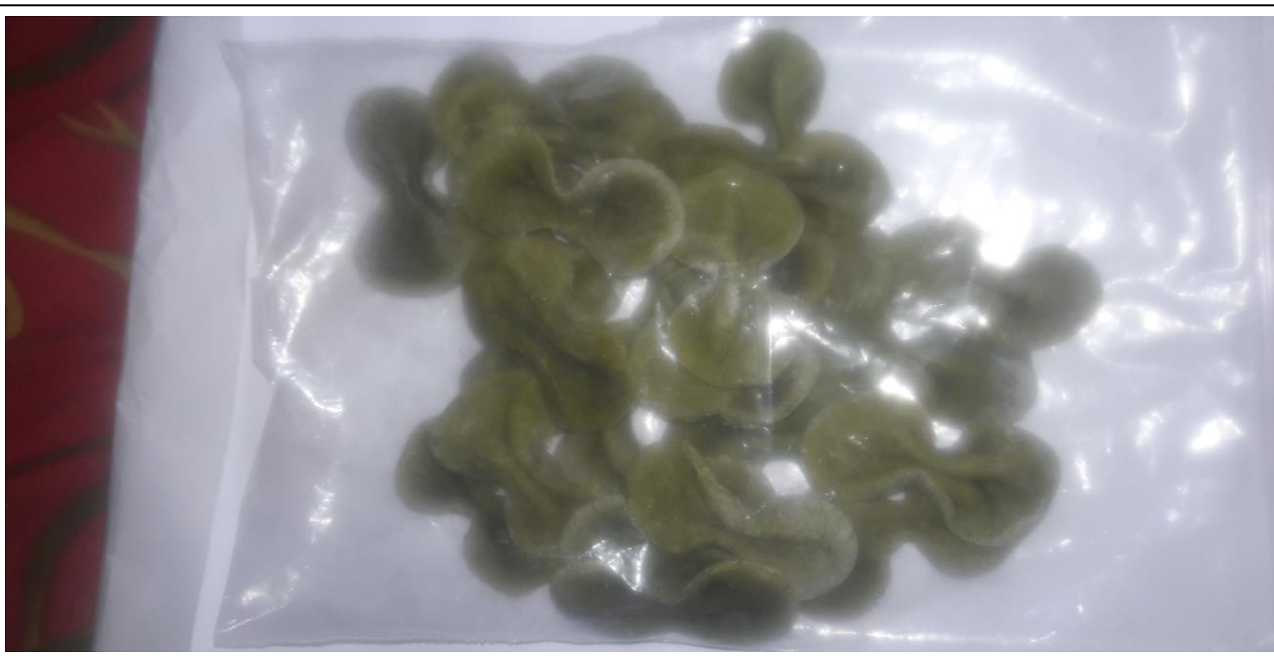


Figure 4.1: before cooking pasta image

Figure 4.2 : after cooking pasta image

4.2 Cooking time

The optimal cooking time for the control pasta was found to be 11 minutes, while the optimal cooking time for the fortified pastas was 10.5 minutes. The decrease in cooking time for pasta products containing non-gluten flour is in accordance with a study by Chillo and others (2008b) who attribute the increase in speed of water penetration of the core to the physical disruption of the gluten matrix caused by the addition of non-gluten material. Grzybowski and Donnelly (1977) found that when less protein surrounds starch granules, they swell and gelatinize faster. These results are similar to those found by Petitot and others (2010b) where the addition of legume flours (split pea and faba bean) led to a decrease in cooking time.

4.3 Cooking Loss

Cooking loss was significantly affected by the addition of Centella asiatica and flours. Table 4.1 shows that the control pasta made with 100% semolina flour had significantly ($p<0.05$) less cooking loss, as percent of original weight, than the formulas containing chickpea and quinoa flours. This is in accordance to reports of others that fortifying pasta with legume flours (pea, lupin, chickpea, lentil, split pea, or faba bean) increases cooking loss (Nielson and others 1980, Rayas-Duarte and others 1996, Zhao and others 2005, Petitot and others 2010b). Lorenz and others (1993) also found that adding quinoa flour to pasta resulted in a higher cooking loss than the control made from wheat flour. As with cooking time, the increase in cooking loss can be attributed to the weakening of the gluten structure from the addition of non-gluten material, allowing more solids from the noodles to leach out into the cooking water (Rayas-Duarte and others 1996). Cooking loss, or cooking water residue, can also be attributed to starch damage, where increased levels of starch damage lead to an increase in cooking loss (Lorenz and others 1993).

Table 3.1 Cooking loss of cooked pasta noodles, as percent of original weight

Formula	*Cooking loss (%)*
15:85 CF	7.68[a]
30:70 CQ	7.74[a]
CTRL	4.22[b]

[a,b] Means within same column followed by same letter are not significantly different ($p>0.05$).

The pasta products made with different ratios of Centella asiatica and flours did not have significantly different cooking losses. This shows that the type of fortification does not affect the cooking loss, but more so the amount of fortification. This is in accordance with Bahnassey and Khan (1986) and Lorenz and others (1993), who found that cooking loss increased as the level of fortification increased.

Although the fortified pastas have a significantly higher percent of cooking loss than the control, they do not exceed 7-8%, which Dick and Youngs (1988) state as the expected range for cooking loss for spaghetti made from semolina flour. Therefore, all pastas in this study have acceptable cooking loss levels.

4.4 Texture measurement

Texture measurement results can be seen in Table 4.2. The hardness, springiness, chewiness of the pasta samples were determined from the texture profile analysis, while firmness was found by an independent test. According to definition, both gumminess and chewiness should not be analyzed for 27 the same sample. Gumminess is a measurement of semisolid foods, while chewiness is the attribute used for solid food products (Bourne 2002). Although the texture profile analysis gave results for gumminess of the samples, it will not be included in this discussion.

4.4.1 Hardness

Hardness of the pastas was significantly ($p<0.05$) affected by the addition of Centella asiatica in flours. Hardness is the height of the force peak of the first compression cycle (Bourne 2002). In this study, it is the maximum force required to compress the sample to 70% of its original height, representing the effort of the jaw to bite down on the sample. The control pasta was found to be significantly ($p<0.05$) less hard than the fortified pasta products. The addition of Centella asiatica with flours decrease hardness of pasta, and more so, the addition of semolina flour has a greater effect on pasta hardness. These results are similar to those found by Petitot and others (2010b) where pasta fortified with 35% legume flours (split pea or faba bean) significantly increased the hardness of pasta, which they attributed to increased protein content and decreased water uptake.

4.4.2 Chewiness

Chewiness is the energy required to chew a solid food until it is ready for swallowing. It is determined as the product of hardness, cohesiveness, and springiness (Bourne 2002). The addition of chickpea and quinoa flours significantly ($p<0.05$) affected the chewiness of the pasta products. With the pastas containing the largest amounts of quinoa flour having the highest levels of chewiness, this again shows that quinoa flour has a profound effect on the textural properties of semolina pasta.

4.5 Color measurement

4.5.1 Lightness

Lightness of the pastas was significantly ($p<0.05$) affected by the addition of Centella asiatica paste with flours. The control pasta was significantly ($p<0.05$) lighter in color than the other samples. The pasta then decreased in brightness ($L*$ value decreased) as the amount of quinoa flour increased. Pasta 15:25 was significantly ($p<0.05$) darker than all the other pasta products. This decrease in brightness of pastas containing legume flours is in accordance with many researchers who have experimented with legumes such as chickpea, green pea, yellow pea, split pea, faba bean, soy, and lentil, as well as pseudo-cereals like quinoa (Lorenz and others 1993, Ugarcic-Hardi 2003, Zhao and others 2005, Wood 2009, Petitot and others 2010b). Oliver and others (1993) attribute the decrease in brightness to a higher ash content in legume flours.

It is known that consumers prefer bright yellow translucent pasta products (Ugarcic-Hardi and others 2003), but the limit of acceptable brightness is undefined. It would be of interest to researchers to perform further consumer studies on the level of acceptability of pasta brightness.

4.5.2 Greenness

Greeness of the pasta was significantly ($p<0.05$) affected by the addition of Centella asiatica with flours. The control pasta was yellow than

Pasta 30% was significantly ($p<0.05$) more green than the other pasta products. It can be concluded that the amount of Centella asiatica with flour added to pasta significantly affects greenness of the product. Similar results were found by spanice and others (2010b) where pasta fortified with faba bean flour saw a significant increase in greenness. Petitot and others (2010b) also noted that yellowness (*b** values) was not affected in this change. This is important to note because according to Ugarcic-Hardi and others (2003), bright yellow pasta is achieved by having both high *b** values and low *a** values.

4.5.3 Yellowness

Yellowness of the pastas was significantly ($p<0.05$) affected by the addition of without Centella asiatica with flours. All *b** values were found to be significantly ($p<0.05$) different from one another. This shows that yellowness is affected not only the addition of semolina flours, but also by the ratio of the flours. The control pasta was found to be the most yellow (highest *b** value), with yellowness significantly ($p<0.05$) decreasing as more Centella asiatica with flour was added. This is in accordance with other researchers who have seen a decrease in yellowness of pastas containing chickpea, green pea, yellow pea, lentil, and quinoa flours (Lorenz and others 1993, Zhao and others 2005, Wood 2009). This decrease in yellowness may be due to the leaching and/or degradation of color pigments, such as carotenoids and xanthophyll (Wood 2009). Since traditional pasta is made of durum wheat which yields a bright yellow product, high levels of yellowness are desirable for pasta (Dexter and Matsuo 1977, Kill 2001a). As whole wheat pastas increase in popularity, pastas that are less yellow in color may become more

acceptable to consumers. The best way to test acceptability of pasta color is by consumer panel. In 2009, Wood included color in a sensory survey and found that there was not a statistical difference in panelist's perception of pasta color.

4.6 Moisture

content because the control had the lowest fat content. This could be linked to fat

The moisture content of dried pasta was highest in the control pasta. There was no clear pattern in moisture content of fortified pastas made with different ratios of Centella asiatica with flours.final of product was moisture below 2%. Its was removed by solar dryer almost 7hour .

4.7 Ash

Ash content had a tendency to be greater in the pasta products made from semolina flours. The control pasta contained the lowest reported amount of ash. This is parallel with the results of Bahnassey and others (1986).

4.8 Texture measurement

Texture profile analysis and firmness tests were conducted using a TA.HDi Texture Analyzer (Texture Technologies Corp., Scarsdale, NY) following the method described by Tang and others (1999). Since texture analyses are affected by temperature, each pasta formula was cooked fresh immediately prior to each test and stored in a Ziploc bag placed in a warm water bath to retain temperature. Data was obtained, calculated, and graphed using the texture analyzer PC software program Texture Expert Exceed (Version 2.62, Texture Technologies Corp., Scarsdale, NY).

4.9 Color measurement

Color values of cooked pasta noodles were obtained using a hand-held Konica Minolta Chroma Meter (Model CR-410, Konica Minolta Sensing, Inc., Japan). Values were reported as Hunter color values where L^* values denote lightness, a^* values signify redness, and b^* values determine greenness. Immediately after being cooked, pasta

noodles were arranged side-by-side in a single layer on a plastic covered white piece of 25 paper. A glass Pyrex petri dish was placed between the surface of the pasta noodles and the Chroma Meter. Four readings were taken from each pasta sample. Testing was performed in triplicate.

5.1 Consumer acceptance testing

Pasta formulations were evaluated for consumer acceptance by 20 untrained panelists. Panelists were recruited based on willingness to participate and consisted of people of various ages (at least 18 years old), genders, and ethnic backgrounds. Testing

was completed in the Nutrition and Food engineering Lab in Daffodil international University following approval from the University of Nutrition and Food engineering Departmental Review Board.

Pasta noodles were prepared in advance and stored in hot pot after cooked. Upon a panelist's arrival, samples of pasta (5-10 grams) were individually served in small plastic cups. A 3-digit random number was assigned to each of the 2 samples, and the order of the samples was randomized. Panelists were asked to taste each sample and rate overall liking before moving on to the next one. To reduce carry-over effect, panelists were given water to help cleanse their palates. A sensory ballot utilizing a 9-point hedonic scale was given with the descriptive options of dislike extremely, dislike very much, dislike moderately, dislike slightly, neither like nor dislike, like slightly, like moderately, like very much, and like extremely. Upon analysis, numbers were assigned to each description with The sensory analysis value are 20 person result was sample like extremely-2, like very much 7, like moderate 8, like slightly 2 dislike slightly 1,Dislike very much 0 Dislike extremely 0.

Table 4.1: sensory analysis SAMPLE 1 Result

		SAMPLE 1 Result						
Like extremely	Like Very much	Like moderately	Like slightly	Neither like nor dislike	Dislike slightly	Dislike moderately	Dislike Very much	Dislike extremely
2	7	8	2	0	1	0	0	0

Table 5.1 : sensory analysis SAMPLE 2 Result

		SAMPLE 2(control) Result						
Like extremely	Like Very much	Like moderately	Like slightly	Neither like nor dislike	Dislike slightly	Dislike moderately	Dislike Very much	Dislike extremely
2	9	5	2	0	0	2	0	0

5.2 Data analysis

Statistical analysis of collected data was performed by the software program SAS® for Windows™ (Version 9.2, SAS Institute Inc., Cary, NC) using the general linear model (GLM) procedure program. Data was analyzed by analysis of variance (ANOVA) at followed by Fisher's least significant difference (LSD) test to compute the smallest significant difference between two means.

CONCLUSION

In this study, the effects of non-traditional flours on cooking quality, texture, composition, and consumer acceptance of pasta were evaluated. Thirty percent of traditional semolina flour used to make pasta was replaced with different ratios of *Centella asiatica* with flours different ratios. Parameters evaluated in this study were cooking loss, texture profile analysis and consumer acceptance. The variables assessed were the ratios 15% and 30% of *Centella asiatica* with flours used.

Results indicated that pasta containing 30% *Centella asiatica* paste had a decreased optimal cooking time of 11 minutes compared to the control pasta time of 13 minutes. Cooking loss was found to be significantly greater for pasta products containing *Centella asiatica* paste . Although the addition of these flours negatively affected the cooking loss, the percentages were still found to be at an acceptable level.

The results of the texture profile analysis indicated that hardness and chewiness were significantly affected by the addition of non-traditional flours. Hardness and chewiness were significantly higher in pastas containing *Centella asiatica* compared to the control. leading to increased values as more *Centella asiatica* was added. Adhesiveness and springiness were not significantly affected by fortification, and was only moderately affected. Pastas maintained high cohesiveness at 15% and 30% formula was found to be significantly less cohesive than the others.

Results of the Hunter color test indicated that the control pasta was significantly lighter than the pastas *Centella asiatica* paste, with those containing the highest amounts of *Centella asiatica* being the more green.. The yellowness of pastas was found to be affected not only by the addition of semolina flour, but also by the ratio of the two additional flours.

Although statistical analysis could not be performed on the results of proximate composition and amino acid analysis, the results were in agreement with many previous studies. The addition of *Centella asiatica* greatly increased the fiber, ash, and amino acid content of pasta, with pasta 30% having the highest values of all of these. From this, it can be determined that the addition of *Centella asiatica* had the greatest effect on fortifying wheat pasta. This could be the result of nutritional composition being lost in the milling process or flour storage. Further studies should be done to better analyze and maintain the nutritional profile of *Centella asiatica*

Finally, results of the consumer acceptance test indicated that panelists significantly preferred the control pasta. Formula 15% received the lowest sensory score of 5.422, which is slightly above neutral. Since all pasta variations received scores above neutral, it was determined that the addition of *Centella asiatica* does not adversely affect the acceptability of pasta products.

In conclusion, the pasta product with the most beneficial ratio of *Centella asiatica* with flours is that containing 15% and 30% *Centella asiatica*. Formula 15% had the highest fiber content and best amino acid profile, along with increased fat and fiber content. Its cooking loss was found to be in an acceptable range, and besides having lower values of cohesiveness, the texture attributes were not adversely affected by fortification. The color characteristics of pasta 30% were also closest to that of the control, leading to a high level of visual acceptability.

Further studies of proximate composition and amino acid profile are still needed to statistically evaluate the influence of adding *Centella asiatica* with flours to pasta. Further assessment of the discrepancies between hardness and firmness should be completed. Finally, in order to better understand the nutritional composition of *Centella asiatica* , it would be valuable to analyze different seed sources and milling processes.

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