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RELATIONSHIP BETWEEN COOKING WATER RESOURCES AND TYPES OF SEMOLINA AND COOKING QUALITY PARAMETERS OF SPAGHETTI

El-Faham, Sawsan Y.* and E. I. Yousif**

* Food Technology Dept., Food Technology & Nutrition Div., National Research Center, Dokki, Cairo, Egypt.

** Food Science Dept., Faculty of Agric., Ain Shams Univ., Shoubra El-Kheima, Cairo, Egypt.

ABSTRACT

The influence of cooking water contents on retention of minerals and cooking quality parameters of spaghetti prepared from durum semolina, wheat flour and their blends (1:1) were investigated by using four cooking waters (Al-Remayah, Belbees, tap water and distilled water) varying in mineral composition. Cooking water analysis confirmed that Belbees and Al-Remayah well waters contained considerable amounts of sodium and calcium being 265 and 208 ppm for sodium and 52.7 and 32.7 ppm for calcium, respectively. Semolina Sohag-containing spaghetti exhibited higher contents of iron and manganese. Type of cooking water and type of spaghetti samples show significant correlations to iron, manganese and copper contents, meanwhile, no significant interactions between the type of cooking waters and type of spaghetti could be detected on the potassium, sodium, calcium, magnesium, phosphorus and zinc contents of cooked spaghetti. A significant interaction of type of cooking waters and type of spaghetti were observed for swelling index(SI), cooking weight (CW) and cooking loss (CL). The alkalinity of the Belbees and Al-Remayaha water did not appear to affect the quality of the products such as (SI) and (CW), however, adversely effect was noticed for the (CL) for samples cooked in Belbees water. Wheat flour-containing spaghetti exhibited the same improvement in (SI) and (CW). The overall acceptability by sensory evaluation correlated significantly with source of cooking water and type of blends. Finally, this research, required further studies to allow more complete understanding of the general relationships shown.

Keywards: Semolina, Wheat flour, Cooking water, Spaghetti, Mineral Content, cooking quality, Sensory evaluation

INTRODUCTION

Several researches have shown that, with increased water hardness, cooked spaghetti has higher stickiness values (Menger,1980; D'Egidio *et al*,1981; Dexter *et al*,1983 and Seibel *et al*,1985), higher total organic materials in the rinse and cooking waters (D'Egidio *et al* ,1981 and Seibel *et al*,1985) and higher cooking losses (Dexter *et al*,1983).

High levels of calcium and magnesium in the cooking water can adversely affect spaghetti cooking quality (Menger, 1980 and Oh *et al*, 1985). Sodium also has a minor effect on surface characteristics of spaghetti (Menger, 1980 and Siebel *et al*, 1985), although D'Egidio *et al* (1981) reported no effect. Irani (1994) demonstrated that correlations were established between pairs of characters which showed that high macaroni quality was dependent on protein and gluten contents of grains. Suzuki *et al* (1999) concluded that cooking loss is one important reason why the chemically analyzed mineral values for diabetic diets are often lower than the calculated values. It is necessary to take care in the preparation of food to minimize the cooking loss of those minerals which are likely to be insufficient specially with low energy diabetic diets. Durum wheat has the hardest grain texture and is suitable for pasta and semolina production, because of high vitreous grain combination of storage protein and yellow pigments (Atli and Ekiz, 2000).

Other workers have demonstrated the importance of cooking water pH on cooking quality of pasta. Alary *et al* (1979) and Abecassis *et al* (1980) noticed that decreased surface disintegration and stickiness and lowered cooking losses of spaghetti by adjusting the pH of mineral water to 6.0. Abecassis *et al* (1980) also adjusted the pH of distilled water and found that spaghetti cooking quality peaked at pH 6.0, on another side of this pH, quality were declined.

Seibel *et al* (1985) revealed that weakly acidic cooking water gave good sensory quality and decreased total organic materials levels. Oh *et al* (1985) indicated that surface firmness of noodles decreased rapidly and cooking losses were increased when pH be more than 8.0. Surface firmness and cooking loss were not affected at pH 6 - 8. Seib *et al* (2000) showed that type of wheat affected the quality of pasta and noodles. Crosbi *et al* (1992), Jun *et al* (1998) and Hatcher *et al* (1999) supported these observations. Moreover, Seib *et al* (2000) emphasized that the alkaline salt is able to boost the uptake of water in the cooked noodles.

Ideally, the cooking water used in the assessment of spaghetti cooking quality characteristics should be typical of what is used in the marketplace and permit discrimination between spaghetti samples.
Using distilled water for water at pH 6.0 is not recommended because it might not allow adequate discrimination between spaghetti samples.

Using artificially hardened water is a practical solution because local water supplies differ from region to another and may fluctuate from season to season.

Therefore, this research was designed to evaluate the effects of cooking water composition on the cooking quality of spaghetti and to show whether spaghetti prepared from semolina Sohag, wheat flour, and their blends behaves the same as spaghetti made from durum wheat semolina (Regina).

MATERIALS AND METHODS

Materials

Selection of cooking waters

Four types of water were selected for research, tap, distilled and two types of well water. The first source of well water was obtained from a few kilometers west of Al-Remayah square, Giza Governorate, Egypt. The second source of well water was obtained from Belbees, El-Sharkia Governorate, Egypt.

Sufficient quantities of all cooking water were collected and stored prior to experimentation to ensure that any differences observed were not due to any day-to-day variations in the water quality of the tap, distilled and well waters.

Source of samples

Durum wheat semolina (RS) was obtained from the Egyptian Company for pasta industry (Regina), El-Sadat City, El-Minufiya Governorate, Egypt; locally wheat semolina (SS) was obtained from Upper Egypt Milling Company (Sohag), Sohag Governorate and wheat flour (WF) was obtained (72 % extraction) from North Milling Company., Cairo, Egypt.

Spaghetti processing and quality evaluation

Preparation of blends

Semolina Regina (SR), Semolina Sohag (SS), Wheat flour (WF) and their blends [SR+SS (1:1), SR+WF (1:1), SS+WF (1:1) and RS+SS+WF (1:1:1)]. A total 1000 g of each blend was prepared.

Spaghetti processing

Spaghetti was prepared from (SR), (SS), (WF)° and the different blends in the laboratory by using (Titania, spaghetti making machine, Italy), water was added stepwise to the aforementioned samples with constant agitation to obtain the right consistency of the dough. Mixing time ranged from 4 -6 min at 30 revolution/min to get a plastic homogeneous mass. The Dough was kneaded and passed through the rollers of machine. Spaghetti was cut by the knife to desired lengths, hardened by allowing to stand for 20 min in air, dehydrated in a dryer at 40 °C ? 2 for 24 hr, then was packed in polyethylene pages and stored in dry place till analysis.

Analytical and cooking tests

A portion of each of uncooked and cooked spaghetti for mineral analysis were dried at 70 °c, then ground in a stainless steel mill and digested according to Chapman and Paratt (1978) using acids mixture consists of nitric, perchloric and sulforic acids in the ratio of 8:1:1, respectively. Phosphorus was photometeric determined according to the vanodate molybdate method of Jackson (1973). Potassium and sodium were measured in the digest by using Pendorf Flame photometer. Magnesium, iron, manganese, zinc and copper were determined using Atomic Absorption Spectrophotometer, Berkin Elemer 1100.

The cooking quality of the spaghetti were measured according to Dexter *et al* (1983) as follows: 5 g in 5-cm strands of each of prepared spaghetti was added to 100 of each boiling tap, distilled, Al-Remayah and Belbees water. Samples were cooked in 250-ml glass beakers to its optimum cooking time (min), which was defined as the time required for white core in the center of strand to disappear. This was determined by removing a strand from the cooking water and crushing it between two glass plates.

All spaghetti cooking tests were recorded in duplicate. Each sample was cooked till optimum cooking time and dried 2 min in a strainer placed over a beaker. For the rinsing treatment, cold water was poured gently over the drained spaghetti in the strainer and the spaghetti was drained an additional 2 min. Each cooked spaghetti sample was weighed immediately after being drained and recorded as a cooked weight of spaghetti in gram. Cooking loss was determined by collecting the rinse water in reweighed glass beaker, which was placed in an air oven at 100 ± 3 °c and the water evaporated to dryness. The residue was weighed and expressed as a percentage of original spaghetti weight. Swelling index was recorded from the ratio of water displacement of cooked spaghetti divided by water displacement of an equivalent amount of uncooked spaghetti.

Sensory evaluation

The cooked spaghetti samples in tap and Belbees waters were chosen for sensory evaluation. Spaghetti samples were cut to 5 – cm lengths and cooked in tap or Belbees water for optimum cooking time. Samples were coded with three digit numbers and presented individually in random order. A10 staff member, untrained panel evaluated samples of the cooked spaghetti. Panelists used hedonic Scale 9-point scale with (1= dislike extremely and 9- like extremely) to evaluate color, flavor, stickiness, tendemess and overall acceptability according to (Larmond, 1970). Evaluation was conducted over a period of the three days, with two sessions per day. Panelists rinsed their mouths with water between samples.

Statistical analysis.

Data were subjected to the proper statistical analvsis using the methods described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

In selecting cooking waters for the research, we respected previous reports that cooking water characteristics, particularly hardness, influences spaghetti cooking properties (Menger, 1980 and D'Egidio *et al*, 1981). Cooking water analysis confirmed that Belbees and Al-Remayha well water contained considerable amounts of sodium 265 and 208 ppm and calcium being; 52.70 and 32.70 ppm, respectively. Meanwhile, Al-Remayah water contained a higher level of potassium 17.70 ppm, followed by Belbees water, being 10.20 ppm (Table,1).

Table(1): Electroconductivity (EC), pH and mineral contents (ppm) of cooking waters.

Minerals / Blends	Al Remaya Water	Belbees Water	Tap Water	Distilled Water
EC	1.90	1.70	7.70	7.10
PH	8.60	8.40	0.10	0.03
Potassium (K)	17.70	10.20	4.35	N.D **
Magnesium (Mg)	5.20	5.12	3.52	N.D **
Sodium (Na)	208.00	265.00	22.70	4.00
Calcium (Ca)	32.70	52.70	Tr.	Tr.
Iron (Fe)	Tr.	Tr.	Tr.	Tr.
Manganese (Mn)	Tr.	Tr.	Tr.	Tr.
Zinc (Zn)	Tr.	Tr.	Tr.	Tr.
Copper (Cu)	Tr.	Tr.	Tr.	Tr.

Ec=Electroconductivity N.D= Not detected Tr.= Traces

The tap water was intermediate in composition between the Belbees, Al-Remayah well waters and the distilled water. From the other side, the pH and electrical conductivity (Ec) for each of the four types of water are provided in the same table. Al-Remayah and Belbees water are alkine (pH 8.6 and 8.4, respectively) when compare to the tap and distilled water (pH 7.7 and 7.1, respectively).

The macronutrients (%) and micronutrients (ppm) of spaghetti prepared from Regina, Sohag semolina (SR, SS), wheat flour (WF) and their blends are recorded in Table (2). Generally, spaghetti prepared from semolina Sohag (SS) exhibited higher contents of iron and manganese, being 52.5, 15.2 ppm, respectively, than the other spaghetti samples i.e (SR) and (WF). The concentration of potassium and magnesium in the spaghetti prepared with (SR) and (SS) are higher than spaghetti prepared from (WF).

Table 2: Macronutrients (%) and Micronutreints (ppm) of uncooked Spaghetti prepared from Regina ,Sohag semolina, Wheat Flour and their blends.

Minerals	Macronuttrients				Micronutrients		
Blends	Ca	K	Mg	Na	Fe	Mn	Zn
Semolina Regina (SR)	0.01	0.21	0.17	0.03	28.50	13.60	34.00
Semolina Sohag (SS)	0.01	0.20	0.16	0.03	52.50	15.20	29.60
Wheat Flour (WF)	0.01	0.14	0.11	0.03	24.00	14.40	17.20
SR +SS (1: 1)	0.01	0.21	0.16	0.03	42.00	13.60	29.60
SR+ WF (1: 1)	0.01	0.18	0.16	0.03	30.00	12.80	24.80
SS+ WF (1:1)	0.01	0.17	0.14	0.03	57.00	14.40	32.00
SR+SS+WF (1:1:1)	0.01	0.18	0.18	0.03	34.50	16.00	29.60

SR = Semolina Regina SS = Semolina Sohag WF = Wheat flour

Furthermore, all spaghetti samples under research have the same content of calcium and sodium (Table, 2). The mean values of macro and micro-nutrients of spaghetti prepared from (SR), (SS), (WF) and their blends after cooking in tap, distilled, Belbees and Al-Remayah waters are summarized in (Table, 3). Calcium and copper contents of spaghetti samples cooked in tap water were higher than those cooked in other type of cooking waters (Table, 3). Elbow macaroni cooked in unsalted tap water contains more calcium than that cooked in distilled water; other minerals were not affected by type of water and addition of salt (Albrecht *et al*, 1987).

In conclusion, type of cooking waters and type of spaghetti samples show significant correlations to iron, manganese and copper contents, respectively. On the other hand, no significant interactions could be detected between the type of cooking waters and type of spaghetti on the potassium, sodium, calcium, magnesium, phosphorus and zinc contents of cooked spaghetti samples under research.

Mean values of swelling index (SI), cooking weight (CW) and cooking loss (CL) of semolina, wheat flour-containing spaghetti as influenced by the type of cooking waters and type of semolina, wheat flour and their blends are presented in Table 4. Generally, significant interaction of type of cooking waters and type of spaghetti were observed for (SI), (CW) and (CL) (Table, 4). The hardness of the Belbees and Al-Remayah waters slightley affect the quality of the products, such as (SI) and (CW) in all spaghetti samples under research. Nevertheless, adversely affect was found for the CL, whereas, higher cooking losses were noticed for spaghetti samples cooked in Belbees water. These effects may be attributed to the greater alkalinity and hardness of the aforementioned source of water, and the up going source of water would be expected to solublize starch to a greater extent than the other sources of water under investigate during cooking accounting for the greater cooking loss. These results agree with those of Dexter *et al* (1983) who observed higher cooking losses for durum spaghetti cooked in well water than in tap water. The cooking loss of durum spaghetti cooked in mineral water was reduced by lowering the pH (Alary *et al*, 1979). Cooking losses were relatively low for pasta-like products: 13.5 and 5.7 % for mung bean starch vermicilli andrice flour noodles, respectively (Mestres *et al*, 1988). Lii and Chang (1981) found only 3.2 % of losses during cookin of mung bean starch vermicelli. These differences could be related to the water quality.

On reverse, our observations did not agree with Kim *et al* (1989) which they revealed that spaghetti made from durum wheat, when cooked in distilled water, had higher cooking losses than spaghetti made from hard red spring wheat, when cooked in hard water. In addition, Malcolmson and Matsuo (1993) also, reported that spaghetti made from durum wheat, when cooked in deionized water, had higher cooking losses than spaghetti made from common wheat, when cooked in the hardest waters. This my be partially explained by the differences in pH of the well waters used in this research and the upgoing studies. Moreover, the calcium (Ca) level of the well water used in this study was lower than the Ca level of the well water used in Malcolmson and Matsuo research (1993). This may be significant because Menger (1980) demonstrated that Ca lowered pH during cooking.

Mean values of (SI) and (CW) of all spaghetti samples enhanced markedly for that cooked in Belbees and Al-Remayah in compared from that observed in tap water and distilled water (Table, 4). The general tendency was for cooking quality except (CL) to be better with wheat flour, Wyland and D'Appolonia (1982) reported an improvement in spaghetti cooking quality with the addition of hard red spring wheat farina to durum semolina. Results of the current study appear to be an increase in cooking loss as wheat flour used. This was anticipated because of increasing starch damage of wheat flour. Wheat flour containing spaghetti brought about some improvement in (SI) and (CW) (Table, 4). These findings confirm the need to use standardized cooking water when comparing results from one test session to another or from one laboratory to another. These observations are in harmony with those obtained by Dexter *et al* (1985) and Malcolmson and Matsuo (1993).

Correlation between source of cooking water, type of blending and sensory evaluation scores of cooked spaghetti are showed in Table (5). The overall acceptability by sensory evaluation correlated significantly with source of cooking water and type of blends. However, the other factors (color, flavor, stickiness, and tenderness) assessed in the sensory data, did not give significant correlations (Table, 5).

Table 3 : Mean values of macronutrients (%) and micronutrients (ppm) of cooked spaghetti as influenced by the type of cooking water and type of semolina, wheat flour and their blends

Minerals composition		Type of cookilg waters and spaghetti samples													
		Spaghhetti cooked in different type of water				Spaghetti prepared from semolina,wheat flour and their blends							L.S.D % at 5%		
		Tap W.	Distilleed	Belbees	Al -Remaya	SR	SS	WF	SR+SS	SR+WF	SS+WF	SR+SS+WF	TCW	TS	TCWxTS
Macronutrients	K	-	0.044	0.080	0.043	0.062	0.062	0.530	0.055	0.053	-	0.054	N S	N S	N.S
	Na	0.023	0.010	0.172	0.177	0.072	0.089	0.095	0.085	0.129	0.100	0.098	0.008	N S	N.S
	Ca	0.2150	0.0016	0.0480	0.0480	0.0291	0.0162	0.0304	0.0375	0.0415	0.0425	0.0325	0.003	N S	N S
	Mg	0.057	0.049	0.079	0.083	0.063	0.073	0.058	0.068	0.073	0.065	0.070	0.008	N S	N S
	P	0.151	0.150	0.160	0.160	0.173	0.170	0.130	0.168	0.153	0.145	0.153	N.S	0.018	N S
Micronutrients (ppm)	Fe	16.910	30.300	28.700	29.100	14.90	37.00	20.20	35.50	17.20	32.50	29.10	0.150	1.283	2.223
	Mn	6.380	9.820	6.740	10.610	8.48	8.44	9.06	7.63	8.87	9.44	6.92	0.007	0.053	0.093
	Zn	12.00	15.80	11.34	19.71	20.20	17.70	11.20	16.70	12.40	14.50	15.20	0.046	0.0176	N.S
	Cu	4.110	2.210	3.640	2.180	3.50	3.19	2.00	3.81	2.94	2.38	3.50	0.975	0.689	0.1948

SR = Semolina Regina
SS = Semolina Sohag
WF = Wheat flour
TW = Tap water
TS = Type of semolina
TCW = Type of cooking water

Table 4: Mean values of swelling index, cooking weight and cooking loss of spaghetti as affected by the type of cooking water and type of semolina, wheat flour and their blends.

Cooking quality	Type of cooking water and,sample blends													
	Type of Cooking Water				Spaghetti prepared from Regina,Sohag Semolina, Wheat Flour and their Blends							L.S.D at 5 %		
	Tap	Distilled	Belbees	Al- Remaya	SR	SS	WF	SR+SS 1:1	SR+WF 1:1	SS+WF 1:1	SR+SS+ WF 1:1:1	Type of water (W)	Type of Bends (B)	Intercatcion (Wx B)
Swelling (SI)	3.37	3.93	4.91	4.93	4.43	4.13	5.00	3.06	5.23	4.49	4,46	0.24	0.33	0.66
Cooking weight (CW)	29.14	24.99	32.97	32.91	28.98	26.31	34.00	24.99	35.98	29.03	30.70	3.41	2.60	5.19
Cooing Loss (CL)	10.71	7.57	16.29	10.57	10.50	10.00	11.50	10.50	12.50	13.50	10.50	1.31	0.85	1.70

SR = Semolina Regina
SS = Semolina Sohag
WF = Wheat flour

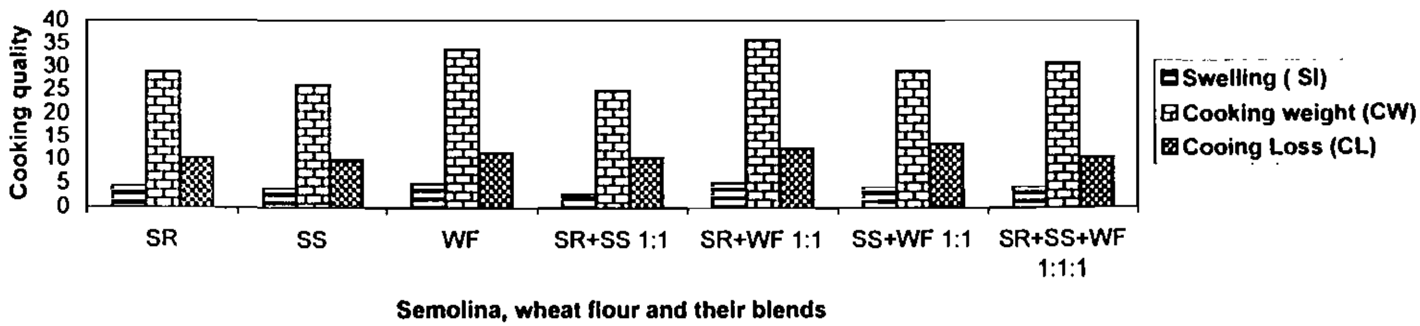

Fig (1): Cooking quality of spaghetti

Table 5: Sensory evaluation of spaghetti prepared from different blends and cooked in two types of water.

Type of water	Blends	Color	Flavor	Sticknss	Tendernss	Overall acceptability
Tape Water	SR	6.40	6 00	4.00	5 20	6 00
	SS	6.80	6.80	4.50	5.60	7.60
	WF	6.00	6.20	3.40	5.20	6 00
	SS+SR 1:1	6.80	7.00	5.20	5.60	7.80
	SR+WF 1:1	6.20	5.80	2.80	5.60	5.80
	SS+WF 1:1	6.40	6.20	4.40	5 00	6.40
	SR+SS+Wf 1:1:1	6.60	6.20	4.40	5.00	6.40
Belbees	SR	6.40	6.00	4.20	5.20	6.00
	SS	6.80	7.00	4.80	5.60	7.80
	WF	6.40	6.20	4.40	5.20	6.00
	SS+SR 1:1	6.60	7.20	5.40	5.40	7.60
	SR+WF 1:1	6.20	5.80	3.00	5.60	5.80
	SS+WF 1:1	6.40	5.80	4.20	4.80	6.60
	SR+SS+Wf 1:1:1	6.80	7.00	5.40	6.00	7.60
Source of water	T.W.	6.46	6.31	4.10	5.31	6.57
	Belbees	6.51	6.43	4.49	5.40	6.77
Blends	SR	6.40	6.00	4.10	5.20	6.00
	SS	6.80	6.90	4.65	5.60	7.70
	WF	6.20	6.20	4.00	5.20	6.00
	SS+SR 1:1	6.70	7.10	5.30	5.50	7.70
	SR+WF 1:1	6.20	5.80	2.90	5.60	5.80
	SS+WF 1:1	6.40	6.00	4.30	4.90	6.50
	SR+SS+Wf 1:1:1	6.70	6.60	4.90	5.50	7.00
L.S.D at 5 %	T.W.	N.S	N.S	N.S	N.S	N.S
	Bl.	N.S	0.76	1.18	N.S	0 48
	T. x Bl.	N.S	N.S	N.S	N.S	0.68

SR = Semolina Regina
SS = Semolina Sohag
W.F = Wheat flour

T.w = Type of water
Bl = Blends
T.W x Bl = Type of water x Blends

In general conclusion, this study suggests that further experiments are required to allow a more complete understanding of the general relationships shown.

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العلاقة بين مصدر ماء الطهى ونوع السيمولينا و مقاييس جوده الطهى للاسباجتى

سوسن يوسف احمد الفحام* و السيد ابراهيم يوسف**
* قسم الصناعات الغذائية – شعبة الصناعات الغذائية والتغذية– المركز القومى للبحوث الدقى – القاهرة – جمهورية مصر العربية.
** قسم علوم الاغذية – كلية الزراعة – جامعة عين شمس – شبرا الخيمة– القاهرة – جمهورية مصر العربية.

تضمن هذا البحث دراسة تاثيرمصدر ماء الطهى على الاحتفاظ بالمعادن وخصائص جودة الطهى للاسباجتى المصنعة باستخدام سيمولينا الديورم(روجينا) ، سيمولينا سوهاج ودقيق القمح وناتج خلط هذة العينات بنسبة (١:١) باستخدام اربع مصادر للمياة تتباين فى محتواها من الاملاح (مياه من بئر منطقة الرماية بالجيزة ، مياة من ابار منطقة بلبيس بالشرقية ، ماء الصنبور ، ماء مقطر). اظهرت نتائج تحليل عينات المياة ، احتواء مياة ابار بلبيس و الرماية على مستويات مرتفعة من الصوديوم والكاسيوم ، ٢٦٥ ، ٢٠٨ جزء / مليون للصوديوم ، ٥٢,٧ ، ٣٢,٧ جزء / مليون للكالسيوم على الترتيب. كما اتضح بتحليل عينات الاسباجتى غير المطهية ، احتواءالعينات المجهزة باستخدام سيمولينا سوهاج على مستويات عالية من الحديد ، المنجنيز عن الاخرى. كما اظهرت نتائج التحليل الاحصائى الى وجود علاقة معنوية بين مصادر المياة المستخدمة فى الطهى وعينات الاسباجتى فى التاثير على المحتوى من الحديد والمنجنيز والنحاس ، وعلى الجانب الاخر ، لم يتضح اى ارتباط معنوى بين المتغيرات السابقة فى التاثير على المحتوى من البوتاسيوم ، الصوديوم ، الكالسيوم ، المغنسيوم ، والفسفور، والزنك لعينات الاسباجتى المطهية ، ايضا هناك ارتباط معنوى بين المتغيرات السابقة فى التاثير على الانتفاخ ، الوزن بعد الطهى والفقد فى الوزن للاسباجتى ، الوزن بعد الطهى و الفقد فى الوزن للاسباجتى ، ولم يظهر اى تاثير سلبى لقلوية مياةا بار بلبيس و الرماية على معامل الانتفاخ والزيادة فى الوزن بعد الطهى ، فى حين كان هنالك تاثير عكسي لمياة ابار بلبيس على الفقد فى الوزن بعد الطهى. ايضا حدث تحسن فى كل من معامل الانتفاخ والزيادة فى الوزن بعد الطهى لعينات الاسباجتى المصنعة من دقيق القمح او من خليط منة مع سيمولينا روجينا او سيمولينا سوهاج. كما تبين ان هناك علاقة معنوية بين درجة القبول العام للاسباجيتى المطهوة فى كل من ماء الصنبور والماء المتحصل علية من ابار بلبيس ، فى حين لم يتضح اى فروق معنوية بين كل من اللون والنكهة وخاصية الالتصاق والطراوة لكل من العينات تحت الدراسة والمطهوة فى المصدرين السابق الاشارة اليهما.

وتعد هذه الدراسة على جانب من الأهمية حيث ثبت ان للماء المستخدم فى الطهي تأثير على جودة الاسباجتي، و كما نعلم فان مصادر المياه تتباين في محتواها باختلاف الطبيعة الجغرافية ومن ثم فانه ينبغي أجراء بحوث في مناطق متعددة على عينات من المكرونة المستخدمة فيها حتى يتسنى التوصل الى خلاصة واضحة في هذا الصدد.

الكلمات الدالة:الاسباجيتى – سيموليا – دقيق القمح – الخلطات – جودة الطهى – التركيب المعدنى – التقييم الحسى.