J. Agric. Sci. Mansoura Univ., 32 (1): 573 - 582, 2007

PREPARATION OF WHITE SALTED NOODLES WITH STARCHES OBTAINED FROM RICE, TAPIOCA AND CHUFA TUBERS

Salama, Manal F. ; A.S. Nadir and Wafaa M.M Abozeid

*** Food Science and Technology Dept., National Res. Centre, Cairo, Egypt.**

ABSTRACT

A study was conducted to determine the suitability of substituting portions of wheat flours with Rice, Tapioca and Chufa tubers (*Cyperus esculentus*) starches for white salted noodles. The levels of substitution were 10, 20 and 30%. Ten formulas were prepared and compared with white salted noodle made from wheat flour only. Analytical methods, viscoelastic properties, cooking quality, colour attributes, Scanning of electron microscopy and sensory evaluation were determined.

Scanning electron micrographs showed that Rice starch was smaller than Tapioca and Chufa starches.

Pasting properties of starches like maximum viscosity was higher for Tapioca and Chufa tubers starches compared to wheat flour and Rice starch. When up to 20% of wheat flour was replaced by Rice and Tapioca starches, the cooking quality of white salted noodles decreased. The sensory evaluation indicated that panelists preferred the noodles made from wheat flour substituted with 10 and 20% Rice, Tapioca and Chufa starches.

Keywords:White salted noodle, Rice starch, Tapioca starch, Chufa tubers starch, Scanning electron microscopy.

INTRODUCTION

White salted noodles are a popular wheat food in Japan. Wheat quality requirements for white salted noodles are bright and creamy colour, smooth and glossy surface appearance, soft texture with a slight surface firmness, and elasticity (Crosbie et al 1998) and (Konik and Miskelly 1992).

The texture of the white salted noodle strongly depends on the variety of wheat used, in general, soft wheat varieties are used for Japanese-type noodle and hard wheat varieties are used for chinase-type noodle (Hou 2001). Because such specific kinds of flours are required for high quality white salted noodle manufacture, many studies have been devoted to selecting new wheat varieties to meet the needs of high-quality white salted noodle production. Toyokawa *et al.* (1989), reported that starch, rather than gluten, is the most important factor determining the quality of Japanese style white salted noodle. However, only a few studies have devoted to the effect of using non-wheat starches on noodles quality Collado and Croke, (1996); Lee and Czuchajowskaz (1998).

At the cooking stage of noodles, Chen et al (2002) reported that, small parts of the starch will be separated and suspended in water, the noodles become weaker and less slippery, and the cooking water becomes cloudy and thick as a function of cooking loss.

Umerie and Okafor (1997)reported that chufa starch (*Cyperus esculentus*) is one of the promising substitutes which may be extracted with cold water ,paste stable, clarity, white in colour ,granule shape, adhesive strength and line-spread at 50 °C.

Tapioca starch is a good candidate to manufacture clear noodles because of its low cost and the clarity of its starch paste. Noodles prepared from Tapioca starch were too soft than that of wheat flour noodles. Kasemsuwan et al(1998).

The lower amylose content of rice starch was reflected in viscoelastic amylograph indicated that rice starch gel is less firm than wheat starch gel (control) Sharp and sharp (1994) .

We expect that the three varieties of starch will also exhibit a positive effect on white salted noodle. The purposes of this study were to investigate and compare the structures and the pasting behavior of Rice, Tapioca and Chufa tubers starches to produce high quality white, salted noodles.

MATERIALS AND METHODS

1. Materials:

Wheat flour (extraction 72%), Rice starch, Tapioca and Chufa tmbers (*Cyperus esculentus*) were purchased from field crops department, Agriculatural. Research center, Giza, Egypt. Tapioca and Chufa tubers were ground into a fine flour in a laboratory milling machine.

2. Methods:

2.1. Starch isolation:

Starches were isolated from Chufa tubers (*Cyperus esculentus*) and Tapioca tubers by the modified methods of parameter (1969), Trease and Evans (1978) and Meyer (1982).

The tubers were weighted out, washed and steeped in potassium metabisulphite solution (0.8133g/1 $k_2SO_2O_5$) at 29.0±1.0°C for 48h the steeping water was changed after 24h. the tubers were then milled using a Moulinex type 276 mill to a slurry which was suspended in 2L of the $K_2S_2O_5$ solution, stirred and allowed to stand for 2 min. afterwards, the starch milk was stirred again and passed through a 100-mesh sieve cloth (coarse sieving), and the suspension allowed to stand for 24h, the supernatant was decanted, the starch sediments collected and resuspended in pure water. The starch milk was then passed through a 260-mesh sieve (fine sieving) Moorthy *et al.*, (1994) and the suspension allowed settling for 8h, the resulting wet starch cake was crushed manually, sun-dried for 24h, and then oven-dried at 50°C for 3h, the sampling was duplicated to give the yield of starch.

2.2. Analytical methods of starches:

Rice, Tapioca and Chufa starches were analyzed for protein and fat as described by AOAC (1990).

2.3. Scanning Electron Microscopy (SEM) of starches:

Rice, Tapioca and Chufa starches were examined using scanning electron microscopy (JSM-Tzo, JEDL, company, Japan) according to the method described by (Hayman *et al*, 1998).

2.4. Viscoelastic behaviour of starches:

Pasting behaviour of starches suspension were measured using a Brabender Amylograph (model OHG Duisbury , Germany) according to the method described by Chen and Voragen (2003).

2.5. Preparation of white salted Noodle:

Control sample of white salted noodles was prepared by mixing 100% wheat flour with 2% sodium chloride solution for 4 min in a pin mixer by Chul and Byung (2004). Wheat flour of treated salted noodles was replaced with starches of Rice, Tapioca and Chufa at a percentage 10, 20 and 30%. Salted noodles product was prepared as follows: Mixed dough passed twice through sheeting rolls, then rested for 1 hr. The thickener of sheeted rolls decreased gradually through three rolls gaps (2.40, 1.85 and 1.30 mm). The obtained dough sheet was cut through cutting rolls (no 12) into a strips ≈ 30 cm in length, with 0.3 x 0.2 cm cross-section. After that, noodles stored for 24 hr in a plastic bags for analysis.

2.6. Functional properties of white salted noodles:

2.6.1. Cooking quality

Weight increase, volume increase, and cooking loss were evaluated according to the methods described by AACC (1983).

2.6.2. Colour evaluation of white salted noodles:

The colour of dried noodles were measured using a tristmulus colour analyzer (hunter lab scan XE reston VA). The instrument was equipped with a measuring head sensor connected to a computer. The instrument was calibrated using a standard white tile: (X = 77.26, Y = 81.94 and Z = 88.14). $L^* = 92.66$, $a^* = 0.86$, $b^* = 0.16$. the colour was measured in terms of redness a^*, yellowness b^* and lightness L^*.

2.6.3. Organoleptic evaluation of white salted noodles:

Organoleptic evaluation was carried out after cooking for 7 min. Products were evaluated by 10 trained panel members from the stuff of the department. Noodles were evaluated in sets of five samples per plate and each set was replicated twice, scores of each characteristic were averaged. Kasemsuwan et al, (1998).

2.7. Statistical analysis:

All data were statistically analyzed using the analysis of variance and least significant difference (L.S.D), according to the method of Gomez and Gomez (1984).

RESULTS AND DISCUSSIONS

3.1. Chemical composition of extracted starches:

Extracted Rice, Tapioca and Chufa starches which used for producing noodles were evaluated chemically as shown in Table (1). The obtained results showed that starch content of these materials ranged between 97.78 – 99.3 %, and its protein content ranged between 0.10 – 0.17%. This result indicated that such extracted starches are accepted chemically and agree with the recommendation of the Egyptian Standard, (1975). On the other hand, Rice starch characterized with its higher yield (83.87%) than those of Tapioca (23.84%) and Chufa (20.51%).

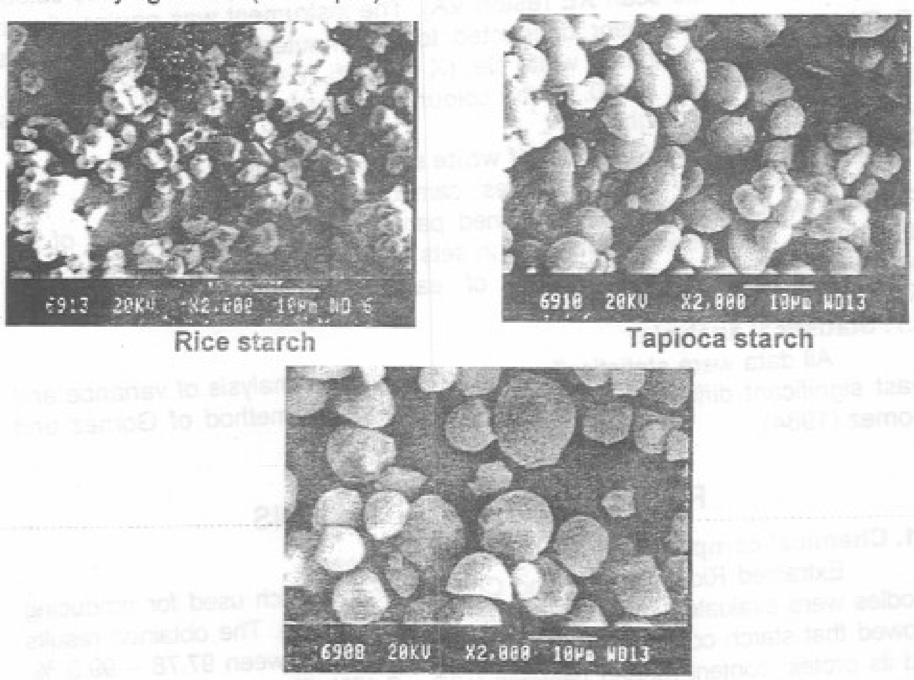
Table (1): Chemical composition of Rice, Tapioca and Chufa starches (Dry weight basis).

Constituents (%)	Rice starch	Tapioca starch	Chufa starch
Starch	99.30	97.78	98.21
Protein	0.14	0.10	0.17
Fat	0.11	0.01	0.14
Yield*	83.87	23.84	20.51

Values are mean of triple determinations. * Yield in wet basis.

3.2. Scanning Electron Microscopy (SEM):

The microstructure of Rice, Tapioca and Chufa starches was investigated with scanning electron microscope (SEM) in order to analyze the relationship between the structure and quality of starch to produce noodles. Photos of Fig (1) illustrate the microstructure of different type of starch granules. Photo (A) showed that, the granules of Rice starch had simple polyhedral grains, rounded and irregular in shape, and varying in size according to the number of consistent grains and masses of starch from the cell of the endosperm. Starch granules of Rice ranged between 5 to 7 µm. Photo (B) declared that, Tapioca starch granules, had irregularly sloped and spherical shape with some truncated granules. The diversity in the shape and size of Tapioca starches granules ranged from 7 to 15 µm and small grooves. Photo (C) showed also that, starch granules of Chufa had spherical shape, and varying in size (6 - 13 µm).



Rice starch

Tapioca starch

Chufa starch.

Fig. (1): Scanning electron microscopy of Rice (A), Tapioca (B) and Chufa (C) starches (magnification X 1000).

Similar result was obtained also by Mishra and Rai (2006). The diversity in the shape and size of starch granules of the previous result could be useful in the identification of different starch species and related granule morphology to starch as suggested by Fannon *et al.* (1992). On the other hand, Singh and Singh (2001) suggested that, the morphology of starch granules depends on the biochemistry of the chloroplast or amyloplast and physiology of the plant.

3.3. Amylographic pasting characteristics:

Table (2) show and compare the amylograph pasting characteristics of Tapioca, Rice and Chufa starches. The obtained data showed that, Tapioca and Rice starches had the same transition point (76.5°C), while Chufa starch increased to reach 91.5 °C. This result indicated that, the temperature at which viscosity began to increase in case of Chufa starch was higher than Rice and Tapioca starches. During heating, the maximum viscosity of Tapioca and Chufa starches reached to 1220 and 1060 BU, at 87 and 99 °C respectively, while Rice starch decreased to 895 BU at 99 °C. These variations in maximum viscosity and temperature of maximum viscosity could be due to starch variety (percentage of amylose and amylopectin) and starch particle size of Tapioca, Chufa and Rice. This result agreed with those observed in photos of Fig (1), where particle sizes of Tapioca and Chufa starches were greater than Rice starch. During cooking at 95 °C for 20 min, the final viscosity of Rice starch decreased to 830, 660 and 400 BU, in Rice, Chufa and Tapioca, respectively, this decrease reflect the decrease in the swelling ability of gelatinized starch compared to rice as suggested by Kamil (2001). Upon cooling to 50 °C, the viscosity of previous samples increased sharply. Set-back viscosity was also determined for measuring the degree of hardening or retro-gradation of cooked Rice during cooling as suggested by Sharp and Sharp (1994). Table (2) showed that, the amylograph consistency and set-back viscosity were higher in Chufa and Tapioca starches than Rice starch reflecting good and less stickiness in Rice starch if used to produce noodles, where Juliano and Sakurai(1985) reported that set-back viscosity correlate to stickiness. Also, Chul and Byung, (2004) declared that the lower peak viscosity of Rice starch could be due to quick disintegration of starch granules under shear and hydrolysis of starch by α-amylase.

Table (2): Pasting properties of Rice, Tapioca and Chufa Starches.

Starches / Pasting properties	Rice	Tapioca	Chufa
Transsion point (°C)	76.5	76.5	91.5
Maximum viscosity (BU)	895	1220	1060
Temp. at max. viscosity (°C)	99.0	87.0	99.0
Viscosity at 95°C (BU)	830	400	660
Viscosity at 50°C (BU)	1095	760	1530
Set –back point (BU)	200	460	470

Values are mean of duplicate determinations.

3.4. Functional properties of white salted noodles:

3.4.1. Cooking quality:

During cooking, it could be notice some variation in noodles, i.e. separation and suspension of small parts of starch in blanched water, and the cooked water became cloudy and thick as a function of cooking loss. Table (3) show and compare the effect of supplementation wheat flour with some other type of starches on increasing the weight, volume and cooking lose of cooked noodles. The obtained results indicated that, weight and volume increase of control noodles (100% wheat flour) reached to 190% and 152.5%, respectively, while cooking loses reached to 7.3%. Substitution wheat flour with Rice starch at a level ranged between 10-30% increased the weight and volume of cooked noodles to 240-277.5% and 160-165 %, respectively, and their cooking loss decreased to 6-6.6%, respectively. But substitution wheat flour with Tapioca starch at the same used level of Rice starch increased the weight and volume of cooked noodles to range between 324-472 % and 157-170 %, respectively, and its cooking lose increased to 7.5-8.8 %. Moreover, substitution wheat flour with Chufa starch at the same used level gave the nearest quality of weight and volume increase of supplemented Rice noodles, and its quality of cooking lose was around the quality of supplemented Tapioca noodles.

Table (3): Effect of supplementation wheat flour with some type of starches on cooking quality* of white salted noodles:

Sample	Weight increase (%)	Volume increase (%)	Cooking loss (%)
Control	190.0 ± 2.44	152.5 ± 2.04	7.3 ± 0.816
Wheat flour replaced with Rice starch at level			
10 %	240.0 ± 3.27	160.0 ± 2.94	6.0 ± 0.16
20 %	261.5 ± 5.71	162.5 ± 5.31	6.6 ± 0.48
30 %	277.5 ± 8.16	165.0 ± 6.53	6.6 ± 0.32
Wheat flour replaced with Tapioca starch at level			
10 %	324.0 ± 2.50	157.5 ± 3.26	7.8 ± 0.65
20 %	472.0 ± 4.08	167.5 ± 5.71	8.8 ± 0.81
30 %	408.5 ± 7.50	170.0 ± 8.16	7.5 ± 0.48
Wheat flour replaced with Chufa starch at level			
10 %	215.0 ± 4.08	154.0 ± 6.53	10.3 ± 0.73
20 %	301.0 ± 3.26	160.0 ± 3.27	8.9 ± 0.40
30 %	275.0 ± 4.08	164.0 ± 3.26	6.0 ± 0.24

Control : 100 % wheat.
*** Data represented as an average of three replicated sample ± standard deviation.**

3.4.2. Colour parameters:

Table (4) shows and compares the effect of different starch type and levels on uncooked noodles colour. The obtained results indicated that, replacing wheat flour with Rice starch improved noodles whiteness (L value) if compared with control sample, where it increased gradually to 74.40, 75.2 and 78.55 at replacement levels 10, 20 and 30%, respectively. Also, replacing wheat starch with Tapioca starch improved noodles whiteness but in a lower rate if compared with those obtained in case of Rice starch replacement, while replacement with Chufa starch had less effect on noodles whiteness, where its (L value) ranged to the nearest value of control sample (68.10). These results could be due to the effect of replacing wheat flour with starch on decreasing some components such as proteins and fiber as suggested by Chen et al (2002).

On other hand, another parameter of colour was also studied to evaluate the degree of redness (a value) and yellowness (b value) of the treated noodles. The obtained result indicated that, replacing wheat flour with Rice or Tapioca and Chufa starches slightly decreased the degree of redness (a) if compared with noodles of control sample, while yellowness (b) of control sample was higher than those obtained in case of replacing wheat flour with Rice or Tapioca and Chufa starches. The resulting values of redness and yellowness of treated noodles could be due to the type of starch which replaced in noodles as mentioned by Chul and Byung (2004).

Table (4): Colour attributes of uncooked white salted noodles.

Samples	L	A	b
Control	68.10 ± 0.816	2.86 ± 0.653	18.53 ± 1.633
Wheat flour replaced with Rice starch at level			
10 %	74.40 ± 10.789	2.29 ± 0.408	14.53 ± 0.735
20 %	75.24 ± 1.633	1.75 ± 0.354	11.68 ± 0.555
30 %	78.55 ± 0.488	1.70 ± 0.653	10.16 ± 0.457
Wheat flour replaced with Tapioca starch at level			
10 %	70.65 ± 0.531	2.91 ± 0.743	16.49 ± 0.400
20 %	70.19 ± 0.637	2.99 ± 0.808	16.42 ± 0.694
30 %	69.62 ± 0.506	2.54 ± 0.686	15.34 ± 0.596
Wheat flour replaced with Chufa starch at level			
10 %	67.85 ± 0.694	2.88 ± 0.719	15.44 ± 0.694
20 %	67.79 ± 0.776	2.65 ± 0.531	13.75 ± 0.612
30 %	68.72 ± 0.588	2.46 ± 0.376	13.18 ± 0.727

*** Data are represented as an average of three values. L = White (100) to black (0)**
a = red (100) to green (-80) b = yellow (70) to blue (-80).

3.4.3. Organoleptic evaluation:

The organoleptic properties of the white salted noodles based on clarity, taste, flavour, chewiness and firmness are clearly shown in Table (5). Control sample of white salted noodles was the best sample among all tested parameters. Meanwhile noodles that replaced with 30% Rice, Tapioca and Chufa starch had a lower score for all tested parameter. Clarity was adversely affected with Rice starch level, where there was no significant difference between 100% wheat flour sample (control) and that replaced with 10% Rice starch, while replacing wheat flour with more than 20% Rice starch decreased the clarity, this result could be due to the high content of Rice amylose. Also, the clarity of noodles did not affect significantly in case of replacing wheat flour with Rice or Tapioca starch at a level 20%. While replacing wheat flour with Chufa starch gave the lowest score for the noodles clarity. On the other hand, taste and chewiness of treated noodles samples not affected significantly in case of replacing wheat flour with Rice, Tapioca or Chufa starch. The flavour of cooked starch noodles that replaced with 10 or 20 % Rice starch was significantly better than those replaced with Tapioca or Chufa starch. While, firmness of cooked noodles slightly affected in all treated samples.

Table (5): Statistical parameters of mean values of organoleptic evaluation of white salted noodles.

Samples	Clarity	Taste	Flavour	Chewiness	Firmness
Control*	8.2^{A}	8.4	8.5^{A}	7.7	8.2^{A}
Wheat flour replaced with Rice starch at level					
10 %	8.7^{A}	8.7	8.6^{A}	8.1	7.3^{AB}
20 %	7.2^{B}	7.4	8.2^{AB}	6.9	6.5^{BCD}
30 %	7.2^{B}	7.3	7.9^{ABC}	7.5	6.3^{BCD}
Wheat flour replaced with Tapioca starch at level					
10 %	6.9^{B}	73	7.3^{CD}	7.0	6.1^{CD}
20 %	6.4^{BC}	6.0	7.2^{BCD}	6.6	6.0^{CD}
30 %	5.8^{CD}	7.1	7.1^{BCD}	6.3	5.7^{D}
Wheat flour replaced with Chufa starch at level					
10 %	5.7^{CD}	7.0	7.3^{CD}	7.1	6.2^{CD}
20 %	5.2^{DE}	6.7	7.1^{D}	7.1	6.8^{DC}
30 %	4.6^{E}	6.6	6.8^{BCD}	7.5	6.5^{BCD}
$LSD_{0.05}$	0.9730	NS	1.0787	NS	1.0389

* Control : 100 % wheat. NS = Not Significant

4. Conclusions:

From the previous results, it could be noticed that the functional properties of Rice, Tapioca and Chufa starches are suitable as a supplemented materials for producing and improving white salted noodles, and it could be recommend to replacing wheat flour of white salted noodles with Rice, Tapioca and Chufa starches to reach 30, 20 and 20%, respectively.

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استخدام النشا المستخلص من الأرز ودرنات التبيوكا وحب العزيز فى إنتاج نودلز مملح

منال فتحى سلامه ، عبد العزيز نذير شحاتة محمد و وفاء محمد محمد أبو زيد
قسم الصناعات الغذائية – المركز القومى للبحوث القاهرة – مصر

- تم استخدام ثلاث أنواع من النشا التى تم استخلاصها من الأرز ودرنات التبيوكا وحب العزيز فى صناعة نودلز مملح بالمقارنة بصناعتها من دقيق القمح بالاستبدال بثلاث نسب ١٠ ، ٢٠ ، ٣٠%.
- وقد تمت دراسة خواص النشا المستخلص وتركيبها الدقيق باستخدام الميكرسكوب الالكترونى وأيضاً دراسة خواص العجينة الناتجة من انواع النشا الثلاث من حيث درجة اللزوجة القصوى و درجة الحرارة التى يحدث فيها انكسار للمنحى بجهاز اميلوجراف بالاضافة للتقييم الحسى للنودلز الناتجة من أنواع النشا المستخدمة وكذلك التغير فى اللون باستخدام جهاز هنتر لقياس الألوان.
- وقد أظهرت النتائج اختلاف حجم حبيبات النشا حيث أن حب العزيز أكبرها حجماً والأرز أصغرها. وأثبتت الدراسات أن نشا التبيوكا وحب العزيز أظهراً اعلى ارتفاع لمنحنى اللزوجة مقارنة بنشا الأرز وأنهما أكثر ثباتاً فى العجينة.
- واتضح من صفات الطبخ أنه كلما زادت نسبة استبدال دقيق القمح بالنشا المستخدم زادت نسبة الفقد فى الطبخ وعلى عكس ذلك زاد وزن وحجم النودلز الناتجة بزيادة نسبة الاستبدال على النودلز المصنعة من دقيق القمح.
- أما بالنسبة للصفات الحسية فقد أثبتت النتائج لعينات النودلز المصنعة أن نسب الاستخلاص ١٠، ٢٠% لأنواع النشا الثلاث المستخدمة كانت أفضل النتائج من حيث الطعم واللون والصلابة والرائحة.