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Influence of Acidity and Sodium Chloride on the Function Properties of Whey Protein Powder

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Abstract: The effectiveness of acidity and supplementation with different concentration of sodium chloride salt on function properties for whey protein powder prepared from salted and unsalted whey were investigated. The resultant whey protein powder was in a denatured form and contained about 50% protein. Whey protein powder from salted whey was generally more water soluble at any particular pH values (pH 2-7). There were no obvious differences between the two types of whey protein powder in their ability to diffuse to the water-oil interface (emulsifying oil in water). Moreover, little differences were observed between the two whey protein powder preparations in their ability for the formation of air dispersion in the liquid phase. Solubility index and foaming properties of whey protein prepared from unsalted whey increased by increased salt concentrations, while emulsifying capacity decreased by increased salt concentration until concentration 8% and dropped at concentration of 10% salt. It could be concluded that ionic strength has an important role in the functionality of whey protein concentrate.

Key words: Whey-protein powder · Ras cheese · Domiati cheese · function properties · Acidity · Salt concentration

INTRODUCTION

Whey contains more then half the solids present in the original whole milk including 20% of the proteins and most of the lactose, minerals and water soluble vitamins. There has been increased recognition that the proteins and lactose in whey are voluble nutrients which should not be wasted [1-3].

The recognition of whey as source of unique physiological and functional attributes has increased incorporation of whey and whey components into a variety of foods. Whey protein, concentrate and whey protein isolate are high protein, low carbohydrate ingredients that are currently in demand due to increased awareness of nutrition and alternative methods for weight control. Dairy products, especially whey protein products, contain high concentrations of vitamins and mineral [4, 5].

In Egypt, most of the whey produced is from Domiati cheese processing (salted whey) little amounts are produced from Ras cheese processing (unsalted whey).

The current work was carried out to investigate. The effectiveness of acidity and supplementation with different concentration of sodium chloride salt on function properties for whey protein powder prepared from salted and unsalted whey.

MATERIALS AND METHODS

Fresh cow's milk was obtained from the herd of the Faculty of Agriculture, Al-Azhar University, Assuit, Egypt. Thermolabile microbial rennet from *mucor miehei* (Gist Brocades France) was used for renneting. Clean good grade cooking salt was used for processing of the cheese. Unsalted whey was obtained from Ras cheese processing at Dairy Department, Faculty of Agriculture, Al-Azhar University, Assuit, Egypt.

Preparation of whey proteins powder: Whey protein powder was prepared from unsalted (Ras cheese whey) and salted (Domiati cheese whey) whey by acidification and heating process. The pH of the whey was acidified to pH 4.6 in the case of unsalted whey before heating. Heating was carried out at 90°C for 10 min, followed by cooling and adjusting the pH to 4.6. After 1 standing overnight, the supernatant was discarded, filtrated through four layers of cheese cloth, air dried at room temperature for 2-3 days then milled.

Chemical analysis: The pH value was measured using pH meter (3310, Jenway Limited, England), equipped with glass electrode. The titratable acidity and salt content was

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determined by the method described by Ling [6]. Total nitrogen (T.N), total protein (T.P) and non protein nitrogen (NPN) were determined by the semi-micro kjeldehl according to the method of IDF [7]. Ash content was determined according to Pearson [8]. A sample (2-3 g) was used for determination of moisture, dried in an oven at 105°C until a constant weight was reached [9]. Solubility of whey protein powder was determined by the method described by Paulsen *et al*. [10] as modified by Modler and Emmons[11]. Emulsifying capacity of whey protein powder was determined according to Slack *et al*. [12]. Foaming properties were determined using the method described by Mohanty *et al*. [13].

RESULTS

Table 1. presents the composition of the major components of unsalted and salted whey. Unsalted whey had low pH, high acidity, T.N, N.P.N and low ash and salt contents, while salted whey had high salt and ash contents.

Whey protein powder from salted whey had higher percentage of moisture and ash as shown in Table 2.

Tables 3 and 4 show the effect of pH values on the function properties of two whey protein powder. The emulsifying capacity of whey protein powder ranged from 104 to 110 ml oil / g protein for unsalted whey and from 111 to 118 ml oil / g protein for salted whey.

Solubility values of whey protein powder ranged from 6.62 to 11.71% for unsalted whey and from 17.50 to 59.01% from salted whey.

Table 1: Composition of Ras Cheese whey (Unsalted) and Domiati cheese whey (Salted)

parameters	R.C.W	D.C.W
pH	4.66	5.18
Acidity	0.35	0.15
Salt%	0.52	5.17
T.N *	156.21	115.84
N.P.N *	61.00	40.00
Ash%	0.65	5.10

R.C.W: Ras cheese whey
D.C.W: Domiati cheese whey
T.N and N.P.N: Denaturmined as mg / 100 ml.
(Average of 3 replicates)

Table 2: Composition of whey protein powder prepared from unsalted and salted whey.

Constituent (%)	R.C.W	D.C.W
Moisture	8.06	11.10
T.N	7.97	8.11
T.P	50.84	51.74
Ash	3.14	12.87

(Average of 3 replicates)

Table 3: Effect of pH values on the function properties of whey protein powder prepared from unsalted whey.

	pH values from 2 to 7					
Properties	2	3	4	5	6	7
Emulsifying capacity *	107	104	105	105	107	110
Solubility index%	11.71	7.10	6.62	8.15	8.80	10.66
Foaming capacity%	119	120	109	102	105	113
Time to collaps min.	9	9	3	2	5	9

* Emulsifying ml oil / g protein

Table 4: Effect of pH values on the function properties of whey protein powder prepared from salted whey.

	pH values from 2 to 7					
Properties	2	3	4	5	6	7
Emulsifying capacity	116	111	115	115	116	118
Solubility index%	30.34	17.50	18.10	20.20	37.15	59.01
Foaming capacity%	114	110	108	109	107	116
Time to collaps min	8	9	2	2	2	9

Table 5: The in influence of sodium chloride concentration on the properties of whey protein powder prepared from unsalted whey.

	Salt concentration (%)					
Properties	0	2	4	6	8	10
Emulsifying capacity	118	111	106	105	90	93
Solubility index%	10.11	39.75	39.70	42.15	45.20	59.30
Foaming capacity%	116	116	116	122	125	136
Time to collaps min	8	9	9	10	22	30

Results in Tables 3 and 4 illustrated the foaming capacity% and time to collaps / min. Little differences are apparent between the two whey protein powder preparations (salted and unsalted) in their ability for the formation of air dispersion in the liquid phase.

Data recorded in Table 5 showed that function properties (solubility index and foaming properties) of whey protein powder prepared from unsalted whey increased by increased salt concentrations. On the other hand, the emulsifying capacity decreased by increased salt concentration until the concentration of 8%, while they dropped at the concentration of 10%.

DISCUSSION

The present study showed increased acidity, T.N and N.P.N for unsalted whey with low pH value and ash and salt contents. On the other hand, salted whey had higher pH value and ash and salt contents, lower acidity, T.N and N.P.N. These differences could be related to the method of processing the two wheys; however, the present data of whey composition were within the recorded ranges [14].

Compositional analysis of whey protein powder prepared from unsalted and salted indicated that the two whey proteins powder had more or less the same T.N and T.P. However, they remarkably differed in their moisture and ash contents. This was expected as in the presence of salt the air drying would not be to tally completed as Nacl has hydro scopic properties in retaming some of the water. The higher percentage of ash in salted whey protein powder is also due to the presence of salt. These results are in agreement with those given by Boumba *et al*. [3] and Patel and Kilara [15].

There was no obvious difference between the two types of whey protein powder in their ability to diffuse to the water-oil interface (emulsifying oil in water). These results were coincided with that previously obtained by Tornberg and Hermansson [16], Schmidt *et al*. [17] and Patel and Kilara [18]. But, generally whey proteins are not considered as good emulsifiers as compared to egg yolk.

It is interesting to note that the protein solubility values of unsalted whey protein powder were quite lower at all pH ranges (pH 2 to 7) than those of salted whey protein powder. Results showed that the factor with the most measurable effect on whey protein functionality, is heat treatment in processing or heating in ingredient application. However, the two wheys were subjected to the same heating temperature, but differed in the pH at which whey proteins were precipitated (pH 4.6 for unsalted whey and pH 2.5 to 3.0 for salted whey). These results were in agreement with those given by Schmidt *et al*. [17],Patel and Kilara [15] and Perez-GAGO and Krochta [18].

Foaming capacity, as assessed in this study by measuring the percentage of volume expansion (volume increase or overrun) and foaming stability, measured as the time required for the foam to collapse revealed little differences between the two whey protein powder preparations (unsalted and salted) in their ability for the formation of air dispersion in the liquid phase. But, generally the values are quite lower than those reported in the literature for other whey protein concentrate preparations.

In the present study, functional properties of whey protein powder prepared from unsalted whey were increased by increasing salt concentrations. This may be suggested that the ionic strength has an important role on the function of whey protein concentrate. The same trend had been reported by Hidalgo and Gamper [20], Schmidt *et al*. [17], Kohn and Foegeding [21] and Brayant and Mcclements [22].

In conclusion, results of this investigation offer simple and early applicable way for useful mean for recovering valuable whey proteins and also to over-come some of the environmental problems caused by wasting the whey into the draining system.

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