Starch Levels in Refrigerated and Frozen Chicken Based Meat Products

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ABSTRACT

The levels of starch were determined in chicken based meat products commercialized in Belo Horizonte, MG, Brazil, from December 1996 to March 1997. Samples were analyzed for moisture and starch contents. Starch was acid hydrolyzed and the resulting glucose was determined at 620 nm after reaction with anthrone. The method was observed to be accurate (92.7% recovery), precise (CV = 3.0%), sensitive (quantification limit = 1.25 g/100 g) and simple in the determination of starch in meat products. Among products analyzed, starch was detected in 100% of meat balls and nuggets samples, in 60% of the sausage, 50% of the bologna and 30% of the frankfurter. Starch was not detected in hamburger samples analyzed. Higher mean starch levels were found in nuggets (14.85 g/100 g) followed by meat balls (4.45 g/100 g), sausage (1.73 g/100 g), bologna (1.14 g/100 g) and frankfurter (0.57 g/100 g). Mean moisture content varied from 35.68 in sausage to 46.24 g/100 g in nuggets. No significant correlation was observed between moisture and starch contents. Every sample of bologna and 90% of the frankfurter contained starch levels according to the Brazilian legislation. Starch levels varied considerably within brands as well as within lots of the same brand.

Key words: starch, chicken based meat products, anthrone method.

INTRODUCTION

The production of poultry meat has increased dramatically over the past 20 years, probably due to low production costs, short grow-out period, advanced production technology, improved feeds and to the high food conversion rate. This increased production associated with small price fluctuation, allowed poultry meat to be a viable alternative as raw material for the manufacture of different poultry based products, among them, refrigerated, cured and frozen products. These processed products are gaining popularity because they have longer shelf-life than fresh meat and are easy to prepare (GODOY FILHO, 1997; SILVA, 1995).

The addition of non-meat ingredients (e.g. dairy products, vegetable proteins or starch) is allowed during manufacture of some meat products. Starch can be added in order to improve product quality by affecting water holding capacity, binding properties, gelling ability and cryoprotection (GARCIA *et al*, 1985; GOMIDE *et al*, 1985; JIMENEZ-COLMENERO *et al*, 1996; LAUCK, 1975; MAURO, 1996; TAKAHASHI, 1993). According to Brazilian legislation (BRASIL, 1962), starch can be added to frankfurter and to bologna at levels up to 2 and 5%, respectively. However, starch is sometimes added at levels higher than the established to reduce production costs and increase yield and profit (AUED *et al*, 1990; SOUZA *et al*, 1990; TAKINO *et al*, 1985), which is considered adulteration or fraud. The levels of starch in beef and pork based meat products have been investigated. According to Table 1, values above the limits established by the Brazilian legislation have been detected (TAKINO *et al*, 1985). Data is not available related to starch level in poultry based meat products.

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Table 1 - Starch levels in beef and pork based meat products and compliance with Brazilian legislation

Samples		Starch (g/100 g)		Attendance to	References
Type	N[1]	Range	Mean	legislation[3] (%)	
Frankfurter					
	5	2.55 - 9.71	5.24 ± 2.86	0	AUED *et al* (1990)
	6	3.77 - 12.88	8.14 ± 3.86	0	BARBOSA *et al* (1995)
	5	1.38 - 13.55	6.24 ± 6.09	40	GARCIA *et al* (1985)
	9	nd - 5.70	2.40 ± 2.02	56	GOMIDE *et al* (1985)
	20	1.57 - 9.68	3.95 ± 3.85	50	HSU *et al* (1977)
	20	1.08 - 5.84	2.64 ± 1.53	50	SOUZA *et al* (1990)
	37	1.61 - 18.41	-[2]	3	TAKINO *et al* (1985)
Bologna					
	3	3.69 - 3.84	-[2]	100	BRUM & TERRA (1989)
	19	1.68 - 6.17	3.28 ± 1.32	11	SOUZA *et al* (1990)
	52	5.49 - 18.2	-[2]	0	TAKINO *et al* (1985)

[1] Number of samples analyzed. [2] Information not available. [3] According to Brazilian legislation levels of starch incorporated into frankfurters and bologna are limited to 2 and 5%, respectively.

Several methods have been used for the determination of starch in meat based products. Due to the complex nature of the sample, analysis is preceded by sample purification to remove interferences such as fat, protein and simple sugars (AUED *et al*, 1990). Starch is then hydrolyzed (acid or enzymatic hydrolysis) and the resulting sugar can be quantified by volumetric (titration) or spectrophotometric methods. Fehling, a volumetric method, presents technical difficulties related to the visualization of the endpoint due to formation of abnormal colorations and/or foam from soy bean saponins; overestimation of results due to the formation of reducing compounds during operation; and applicability only to samples containing starch levels higher than 3% (AUED *et al*, 1990; GARCIA *et al*, 1985; SOUZA *et al*, 1990; TAKINO *et al*, 1985). Spectrophotometric procedures such as the Somogyi-Nelson (AUED *et al*, 1990; BARBOSA *et al*, 1995), the 3,5-dinitrosalicylic acid (BARBOSA *et al*, 1995) and the anthrone method (MORAES & CHAVES, 1988; STEVENS & CHAPMAN, 1955) have been used, and are considered the most suitable for the determination of starch in meat products. According to MORAES & CHAVES (1988), the anthrone method was observed to be accurate, precise and simple in the determination of starch in samples containing levels of 8 to 13 g/100 g. Therefore, it would be interesting to investigate the application of this method for routine quality control of meat based products.

The objective of this work was to determine the levels of starch in chicken based meat products, using a method based in the acid hydrolysis and spectrophotometric detection after reaction with anthrone.

MATERIAL AND METHODS

Chicken based meat products, with origin certified by the Serviço de Inspeção Federal (Federal Inspection Service), including frankfurter (hot dog), bologna, sausage, hamburger, meat balls and nuggets (10 samples of each), were purchased at the retail market of Belo Horizonte, MG, Brazil, from December 1996 to March 1997. Samples were kept under refrigerated or frozen storage until analysis, which was performed before products expiration date.

In order to standardize the methodology, known quantities of starch were added to 100 g of bologna and nuggets, in duplicate. Samples were analyzed before and after starch addition and percent recovery was determined.

Samples were ground, homogenized and analyzed for moisture (IAL, 1985) and starch contents in triplicate. For starch determination, extraction and acid hydrolysis were performed according to the methodology described by AUED *et al* (1990), with modifications. Its quantification was carried out according to the procedure described by MORAES & CHAVES (1988) and STEVENS & CHAPMAN (1955) as follows: fat was removed from samples (0.5 g) using five 5 mL portions of diethyl ether, mixing thoroughly, and centrifuging at 1500 rpm for 5 minutes. Simple sugars were eliminated through eight 5 mL successive extractions with 80% ethanol (80°C), mixing thoroughly, and centrifuging at 1500 rpm for 5 minutes. Supernatants were discarded. After drying the residue at 70°C for 20 minutes, acid hydrolysis of starch was accomplished at 100°C with 10 mL of 0.5 *N* sulfuric acid (Merck, Darmstadt, Germany). The duration of the hydrolysis was 1 hour for frankfurter, bologna, sausage, hamburger and meat balls and 2 hours for nuggets, shaking occasionally. Contents were transferred to a volumetric flask of 500 mL and the volume was brought up with distilled water. A 2 mL volume of this hydrolizate was added to 10 mL of 9,10-dihydro-9-oxoanthracene (anthrone) under acidic conditions (0.1 g/100 mL of 76% sulfuric acid), kept in a boiling water bath for 10 minutes and then cooled in the dark for color formation (20 min). A blank was prepared with distilled water instead of sample extract. The absorbance was determined at 620 nm in a Shimadzu UV-Vis 160 spectrophotometer (Kyoto, Japan).

The concentration of glucose was calculated by the standard curve $Y = 0.0026x + 0.0123$, where Y = absorbance (sample - blank) and x = glucose concentration ($r^2 = 0.9981$). The concentration of starch was calculated by multiplying the value obtained for glucose by the conversion factor 0.9.

RESULTS AND DISCUSSION

Initial studies indicated low recoveries (60 - 70%) for products containing high starch levels suggesting that one hour was not enough for complete hydrolysis of the starch. Studies undertaken to investigate the ideal time for hydrolysis of samples, indicated that two hours were necessary for products containing starch levels higher than 10 g/100 g. Taking this criteria into consideration, mean recovery of 92.7% (CV = 3.0%) was obtained for bologna and nuggets spiked with different amounts of starch as shown in Table 2. The quantification limit, determined according to POMERANZ & MELOAN (1994) and WERNIMONT (1985), was 1.25 g/100 g.

The obtained results confirm that this method is accurate, precise and sensitive. Furthermore, it is simple, requires little manipulation and uses small amounts of reagents and samples. Therefore, it is efficient for the routine quality control of chicken based meat products.

Among products analyzed, starch was present in 100% of meat balls and nuggets samples, in 60% of sausage, 50% of bologna and 30% of frankfurter. Starch was not detected in hamburger samples.

Higher mean starch levels (Table 3) were detected in nuggets (14.85 g/100 g). This is consistent with its formulation and processing (GODOY FILHO, 1997), which consists in covering the meat with coating liquid (cereal flour, modified starch and sugars) and with coating flour (wheat flour; breading; modified starch; rice, corn, cassava and potato flakes; crackers; etc.). The meat balls contained mean starch levels of 4.45 g/100 g, sausage contained 1.73 g/100 g, bologna contained 1.14 g/100 g and frankfurter 0.57 g/ 100 g.

Table 2 - Recovery of starch from bologna and nuggets spiked with different starch levels

Starch level[1] (g/100 g)		Recovery	Mean recovery
Added	**Found**	**(%)**	**± sd**
Bologna			
3.0	8.02	96.9	95.5 ± 2.0
	7.96	94.4	
4.0	9.49	97.2	94.0 ± 4.4
	9.24	90.9	
5.0	10.06	89.2	90.0 ± 1.1
	10.14	90.8	
6.0	11.09	91.5	92.6 ± 1.5
	11.05	90.9	
Nuggets			
2.5	10.75	90.0	93.0 ± 4.2
	10.90	96.0	
5.0	13.20	93.9	92.6 ± 1.7
	13.07	91.4	
10.0	17.51	90.1	92.5 ± 3.4
	17.99	94.9	

[1]The levels of starch in bologna and nuggets prior to starch addition were 5.6 and 8.5 g/100 g, respectively.

The levels of starch detected in samples of frankfurter and bologna analyzed were lower than those detected in beef and pork based products (Table 1). Moreover, compliance with Brazilian legislation was higher for chicken (100% of bologna and 90% of frankfurter samples) compared to beef and pork based products.

There was large variability on moisture contents expressed in g/100 g of the products: 35.75 to 40.47 (mean 38.05 ± 1.42) for frankfurter, 37.27 to 44.60 (mean 41.16 ± 2.69) for bologna, 22.32 to 42.84 (mean 35.68 ± 7.04) for sausage, 30.10 to 44.28 (mean 37.51 ± 4.74) for hamburger, 30.59 to 48.41 (mean 38.87 ± 4.83) for meat balls and 41.77 to 49.49 (mean 46.24 ± 2.75) for nuggets. No significant correlation was observed between moisture content and starch level.

The levels of starch detected in different brands of a product varied significantly ($p \leq 0.05$, Duncan test), especially in meat balls and nuggets. Such differences could be related to distinct formulations used by different industries and to the lack of standards of identity and quality for these new products. The significantly lower value found in nuggets from brand D, is probably related to the fact that it was a 'light product' and had a thinner coating layer compared to the other samples. Significant variation was also observed on starch levels among products of different lots from a brand. Larger coefficients of variation were observed for frankfurter (CV = 170%) and bologna (CV ≤ 118%). These results suggest that, as reported by GOMIDE *et al* (1985) for Vienna frankfurter, there seems to be a lack of standardization on product formulations from industry to industry as well as within different lots of an industry.

Table 3 - Starch levels in different types and brands of chicken based meat products

Meat products/ brands	Number of samples	Starch levels (g/100 g)	
		Range	Mean ± sd
Frankfurter			
A	10	nd - 2.62	0.57 ± 0.96
total	**10**	**nd - 2.62**	**0.57 ± 0.96**
Bologna			
A	4	nd - 3.04	1.29 ± 1.54[a]
B	6	nd - 2.89	1.04 ± 1.23[a]
total	**10**	**nd - 3.04**	**1.14 ± 1.28**
Sausage			
A	4	nd - 3.19	1.38 ± 1.63[a]
B	4	1.75 - 4.93	2.95 ± 1.38[a]
C	2	nd	0.00
total	**10**	**nd - 4.93**	**1.73 ± 1.70**
Hamburger			
A - E	**10**	**nd**	**0.00**
Meat balls			
A	2	4.72 - 5.15	4.94 ± 0.31[a]
B	2	3.14 - 3.31	3.22 ± 0.12[b]
C	3	2.48 - 3.71	2.90 ± 0.71[b]
D	3	5.48 - 8.43	6.51 ± 1.67[a]
total	**10**	**2.48 - 8.43**	**4.45 ± 1.83**
Nuggets			
A	3	24.36 - 46.80	35.17 ± 6.70[a]
B	2	11.93 - 19.13	16.61 ± 4.60[c]
C	3	19.80 - 26.67	22.79 ± 3.52[b]
D	2	3.90 - 4.69	4.30 ± 0.56[d]
total	**10**	**3.90 - 46.80**	**24.85 ± 9.45**

Mean values (± standard deviation - sd, calculated using zero for levels below quantification limit - nd ≤ 1.25 g/100 g) with the same superscript for the same type of product do not differ significantly ($p \leq 0.05$, Duncan test).

RESUMO

Os teores de amido foram determinados em produtos a base de frango comercializados em Belo Horizonte, MG, no período de dezembro de 1996 a março de 1997. As amostras foram analisadas quanto aos teores de umidade e amido. O amido foi submetido a hidrolise ácida e a glicose resultante foi determinada a 620 nm após reação com antrona. O método apresentou exatidão (92,7% de recuperação), precisão (CV = 3,0%), sensibilidade (limite de quantificação = 1,25 g/100 g) e simplicidade na determinação de amido em produtos cárneos. Dentre os produtos analisados, amido foi detectado em 100% das amostras de almôndega e empanado, 60% das de lingüiça, 50% das de mortadela e 30% das de salsicha. Amido não foi detectado nas amostras de hambúrguer analisadas. Teores médios mais elevados de amido foram encontrados em empanado (14,85 g/100 g) seguido de almôndegas (4,45 g/100 g), lingüiça (1,73 g/100 g), mortadela (1,14 g/100 g) e salsicha (0,57 g/100 g). O teor médio de umidade variou de 35,68 em lingüiça a 46,24 g/100 g em empanado. Todas as amostras de mortadela e 90% das de salsicha atenderam a legislação vigente quanto aos teores de amido. Foi observada variação nos teores de amido entre produtos de diferentes marcas e de uma mesma marca.

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Received: June 06, 1998;
Revised: July 17, 1997;
Accepted: November 06, 1998.