PHYSICOCHEMICAL PARAMETERS RELATED WITH QUALITY OF JERKED BEEF, AN INTERMEDIATE MOISTURE MEAT PRODUCT

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Background

Jerked beef (JB) is a meat product derived from charqui, the most traditional Brazilian typical meat product. The main difference between them is the addition of cure salts to the meat at the starting of JB processing. Both products are intermediate moisture food (IMF), according to Hurdle Technology concept (Leistner, 1985, 1987), rendering them stability at room temperature for several months. Legal standards of these products recommended ash and moisture values of 15 and 45% (5% allowable variation), respectively (Brasil, 1962, 1978). Recently, Brazilian Ministry of Agriculture stated new standards for JB, which are: maximum of 55% for moisture, 18.3% for ash, 50 ppm for sodium nitrite and 0.78 for water activity (Aw) (Brasil, 2000). From these legal parameters, the easiest measurement is for moisture content. The relationship between moisture content and the other legal parameters may represent an important predictive tool to be available for food industry.

Objectives

The aim of this work was to investigate the evolution of some physicochemical properties throughout JB processing, in order to obtain predictive parameters for legal standards for legislation.

Methods

Samples were collected from 12 different points at JB processing industrial line, in São Paulo State (Industrias Allyson, Santana de Parnaiba). The following physicochemical characteristics have been evaluated: moisture, ash, NaCl and $NaNO_2$ concentration, according to AOAC (1980) methodology; Aw was monitored by Novasina equipment Model TH2/RD-33BDS; lipid oxidation, using 2-tiobarbituric acid method (TBA), according to Tarladgis et al. (1960) and Torres et al. (1989); pH, determined by Procyon equipment Model PHIE 800. Descriptive statistics were performed with the calculations of mean and standard deviation for each studied variable in every selected point and Pearson linear correlation coefficient among the studied variables in all points. Inferential statistics were performed through regression and variance analysis (Zar, 1984).

Results and discussion

The evolution of the physicochemical parameters throughout JB processing is shown in Table 1. Table 2 shows that moisture, ash and Aw values are highly correlated. This high correlation allowed to fit simple regression lines considering moisture as independent variable (the easiest measured parameter), according to the following models:

1. $Ash = \beta_o + \beta_1.moisture + \varepsilon$;
2. $Aw = \beta_o + \beta_1.moisture + \varepsilon$,

where β_o and β_1 represent the estimated parameters and ε the random error.

According to ANOVA, moisture can explain ash and Aw variability (p=0.001), with adjusted coefficients of determination of $R_{adj}^2 = 81.5\%$ and 87.9% for ash and Aw respectively. The fitted equations can be used to predict future values of ash and Aw in the product at given values of moisture. A positive linear relation between TBA and NaCl values was verified because of NaCl oxidizing role. In addition, Torres et al. (1989) have found trace elements such as iron and copper in the coarse salt used for JB production, which could accelerate lipid oxidation. A negative linear relation was also observed between TBA and moisture/Aw values, since low values for Aw, within JB variation limits, can enhance lipid oxidation (Labuza, 1980; Rockland and Nishi, 1980; Fennema and Carpenter, 1984). Judge et al. (1989) mentioned that there is a tendency for lipid oxidation during meat drying process and suggested the use of antioxidants. Many authors pointed out the role of nitrite as antioxidant, although the minimum concentration for this activity is under consideration (Wirth, 1989, 1991; Vösgen 1992). According to Müller (1991), meat products are complex media, which make it difficult to define the minimum nitrite concentration to promote this antioxidant activity. In this work, $NaNO_2$ maximum concentration during JB processing was around 40 ppm, not exceeding legal standard. Moreover, it was found a slight but significant negative correlation between $NaNO_2$ and TBA, that indicates the antioxidant activity of $NaNO_2$. Table 3 presents the fitted regression line coefficients with ash concentration and Aw as dependent variables and Table 4 presents ash concentration and Aw predicted values well as the prediction limits (95% confidence level). These results showed the suitability of the nowadays legal Brazilian standards of JB quality. Besides that, it was demonstrated that ash and Aw values can be estimated by adjusted line equations ($Ash = 38.725 – 0{,}404.moisture$ and $Aw = 0.3496 + 0.0084.moisture$). By using moisture as a predictive factor for the JB legal standards, does not guarantee the other parameters to attain the legal limits. On the other hand, it was demonstrated that, for a given moisture value, the increase in ash values lead to a decrease in Aw values and vice-versa. According to Hurdle Technology concepts, this interchange among the rigidity of the hurdles does not implicate in damages to the safety of the product. Finally, our results showed the possibility to apply statistic tool to predict results and may help the Brazilian inspection work for JB.

Conclusions

This work demonstrated the correlation among the physicochemical parameters and the possibility of using moisture data in order to predict ash and Aw values for JB.

Pertinent literature

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Table 1. Evolution of physicochemical parameters during JB processing and storage (means ± SD)

Days of processing	**Moisture (%)**	**Ash (%)**	**NaCl (%)**	**Aw**	**$NaNO_2$ (ppm)**	**pH**	**TBA**
0 (raw meat)	76.66 ± 0.71	1.24 ± 0.15	0.24 ± 0.09	0.976 ± 0.022	3.09 ± 2.76	5.75 ± 0.09	0.4330 ± 0.0951
1	71.44 ± 1.24	8.58 ± 0.59	7.50 ± 0.61	0.948 ± 0.028	39.26 ± 12.32	5.82 ± 0.09	0.4572 ± 0.0129
2	71.08 ± 2.42	9.87 ± 1.11	8.78 ± 0.92	0.916 ± 0.017	41.08 ± 18.99	5.65 ± 0.03	0.3174 ± 0.0084
3	67.05 ± 1.75	10.89 ± 2.11	9.91 ± 2.21	0.897 ± 0.045	34.18 ± 15.35	5.81 ± 0.09	0.6990 ± 0.2727
4	61.43 ± 5.42	14.18 ± 1.50	13.09 ± 0.48	0.851 ± 0.027	24.91 ± 7.32	5.97 ± 0.02	0.4847 ± 0.0401
7	65.31 ± 1.65	13.38 ± 1.11	12.02 ± 1.10	0.868 ± .026	11.55 ± 0.43	5.72 ± 0.04	0.7443 ± 0.4124
8	66.75 ± 1.58	11.82 ± 0.61	10.87 ± 0.30	0.861 ± 0.025	13.37 ± 5.23	5.68 ± 0.04	0.9125 ± 0.7687
10	56.66 ± 1.59	17.18 ± 0.84	15.49 ± 1.00	0.809 ± 018	4.00 ± 0.63	5.82 ± 0.04	0.6984 ± 0.1383
12	62.86 ± 2.33	13.55 ± 0.66	12.28 ± 0.84	0.850 ± 0.012	5.58 ± 0.71	5.66 ± 0.03	1.0073 ± 0.8090
15 (ready prod.)	52.13 ± 1.27	18.05 ± 0.87	16.50 ± 0.63	0.748 ± 0.012	8.61 ± 5.12	5.85 ± 0.01	1.2409 ± 0.2043
2 m. packaged	56.52 ± 3.15	14.72 ± 0.34	13.10 ± 2.21	0.805 ± 0.013	3.79 ± 4.21	5.71 ± 0.07	1.0109 ± 0.2347
4 m. packaged	56.83 ± 1.04	12.48 ± 1.23	10.31 ± 3.33	0.836 ± 0.016	4.61 ± 0.71	5.55 ± 0.13	0.8105 ± 0.0533

Table 2. Pearson linear correlation among the studied variables

Variáveis	Moisture	Ash	NaCl	$NaNO_2$	Aw	TBA	pH
Moisture	1.000						
Ash	-0.907**	1.000					
NaCl	-0.876**	0.985**	1.000				
$NaNO_2$	0.658**	-0.665**	-0.665**	1.000			
Aw	0.940**	-0.912**	-0.898**	0.635**	1.000		
TBA	-0.414*	0.449*	0.423*	-0.353*	-0.422*	1.000	
pH	-0.241^{ns}	0.290^{ns}	0.290^{ns}	0.141^{ns}	-0.272^{ns}	0.011^{ns}	1.000

*p<0.05; **p<0.01; ^{ns} non-significant (p>0.05)

Table 3. Fitted regression line coefficients - Ash concentration and Aw as dependent and moisture as independent variables

dependent variable	independent variable	coefficient	std. dev.
Ash	intercept	38.725	2.284
	moisture	-0.404	0.036
Aw	intercept	0.3496	0.0352
	moisture	0.0080	0.0006

Table 4. Ash and Aw predicted values for determined moisture contents and prediction limits with 95% confidence level

moisture limit (%)	Ash predicted values (%)	lower and upper 95% prediction limits	Aw predicted values	lower and upper 95% prediction limits
45	20.530	[17.579; 23.481]	0.708	[0.662; 0.753]
50	18.508	[15.704; 21.313]	0.748	[0.704; 0.791]
55	16.487	[13.785; 19.188]	0.787	[0.746; 0.829]