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Psychophysical estimation of acid intensity and determination of sweet-acid interaction in a fish paste containing glycerol

Estimación psicofísica da intensidade ácida e determinação da interação ácido-doce em patê de pescado contendo glicerol

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Abstract

In a fish paste made with cooked Brazilian flathead (*Percophis brasiliensis*), glycerol (17%), sodium chloride (1.5%) and potassium sorbate (0.1%) the following acid percentages: 0.2; 0.4; 0.6; 0.8, 1 and 1.5% w/w were incorporated to determine the relationship between added acetic acid and the sensorially perceived intensity, and the effects of the combination of sweet-acid tastes. Tests for paired comparison, ranking and structured verbal scales for sweet and acid attributes and psychophysical test were carried out. There was a perceptible difference among samples for differences of 0.4 units of acid concentration. Samples indicated as sweeter by 89.47% of the judges were those containing a lesser acid concentration. A reduction in glycerol sweetness when increasing acid levels was observed. Acetic acid reduced the sweetness of glycerol and inversely glycerol reduced the acidity of acetic acid. The data obtained with the magnitude estimation test agree with Steven's law.

Keywords: fish products; intermediate moisture; sensorial tests; taste interactions.

Resumo

Foram incorporados glicerol (17%), cloreto de sódio (1,5%) e sorbato de potássio (0,1%) nas seguintes porcentagens de ácido: 0,2; 0,4; 0,6; 0,8; 1 e 1,5% p/p, em um patê elaborado a partir de congrio-real (*Percophis brasiliensis*) cozido, com o intuito de determinar a relação entre o ácido acético adicionado e a intensidade sensorialmente percebida, assim como o efeito da combinação dos gostos doce e ácido. Foram realizados testes de comparação pareada, de classificação e também estruturada uma escala verbal para os atributos ácido e doce, e testes psicofísicos. Foi percebida diferença entre as amostras com diferença de 0,4 unidades de concentração de ácido. As amostras indicadas como as mais doces por 89,47% dos julgadores foram as que continham menor concentração de ácido. Foi observada a redução da doçura do glicerol quando aumentaram os níveis de ácido. O ácido acético reduziu a doçura do glicerol e, inversamente, o glicerol reduziu a acidez do ácido acético. Os dados obtidos com o teste de estimação de magnitude concordaram com a lei de Steven.

Palavras-chave: produtos de peixes; umidade intermediária; testes sensoriais; interação dos gostos.

1 Introduction

This work analyzed from sensorial point of view the development of a fish product using combined process or Hurdle Technology. The fish species chose was Brazilian flathead (*Percophis brasiliensis*) and the product an intermediate moisture fish paste.

Brazilian flathead is a species of fish from coastal and benthic habitats. Its distribution ranges from the latitude of Rio de Janeiro in Brazil to 47°S in Argentina. The size of the resource in Argentina is moderate, being underexploited (CFP, 1998). It is used for export as frozen skinless fillets and fresh for the domestic market. It is one of the species open to increased catches without going into over-fishing and is susceptible to greater added value and different presentation (COUSSEAU; PERROTTA, 2000).

In order to obtain sterility and stability without using severe thermal treatment the fish paste was designed to obtain a_w values lower than 0.92 and pH lower than 6.2. Moreover,

fillets were cooked in order to promote enzymatic inactivation, and potassium sorbate was added as antimycotic agent. For the decrease in a_w , sodium chloride and glycerol were used. To increase microbiological stability, a weak organic acid was added taking into account its behavior in food (GARDENER, 1966; MULTON, 1988; LÜCK, 1977; MURRAY et al. 1997; GUERRERO, 1993). Weak organic acid promotes modifications in sensorial characteristics; consequently, considering the modification of taste, it is important to select the appropriate acid for this type of product (GARDENER, 1966; LÜCK, 1977; MULTON, 1988; FISHER; SCOTT, 2000). Acetic acid was selected for this fish paste due to its consumer acceptance, recorded in previous works on fishing products (MULTON, 1988; YEANNES; CASALES, 1995), but is important to note that at certain concentrations acetic acid can be aggressive (FISHER; SCOTT, 2000). Glycerol affects texture and taste: it has a plastifying effect on the texture

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(MULTON, 1988; SÁNCHEZ PASCUA et al., 1994 a; SÁNCHEZ PASCUA et al., 1994b) and in certain concentrations, it has a bitter or sweet taste, so it needs to be considered that some residual taste could appear (JAYARAMAN; DAS GUPTA, 1978; MULTON, 1988, SÁNCHEZ PASCUA et al., 1994a). For this reason, the concentrations of substances used in this work are limited by the consumer acceptance, and their combination offers an interaction of stimuli which may produce enhancement, synergy, suppression and/or residual tastes.

The sweet-acid combination has been studied from the sensorial point of view in solutions, fruits, fruit juices and fruit pulps (PANGBORN; CHRIP, 1964; PANGBORN; TRABUE, 1964; SCHIFFERSTEIN; FRIJTERS, 1990; BONNANS; NOBLE, 1993; MARSH et al., 2003; MARSH et al., 2006). These authors determined that sweet/acid combination exhibited a mutual masking effect; it was demonstrated that citric acid suppresses the sweetness of sucrose and that, inversely, sucrose suppresses the sourness of citric acid. In fish products the sweet-acid combination has been used, such as fish marinated with acetic acid and sugar (MCLAY, 1972; MEYER, 1965), Casales and Yeannes (2006) used acetic acid and sorbitol in anchovy marinating, where sorbitol provide sweet taste. These products were pleasant from the sensorial point of view but no studies of sweet-acid interaction were undertaken.

Taking into consideration the abovementioned, the objectives of the present work were to determine the relationship between added acetic acid and the sensorially perceived intensity, and the effects of the sweet-acid combination taste on an intermediate moisture fish paste using glycerol as humectant.

2 Materials and methods

2.1 Intermediate moisture fish paste

Fillet of Brazilian flathead (*Percophis brasiliensis*) were cooked and minced to use in a fish paste, incorporating 17% of glycerol, 1.5% of sodium chloride and 0.1% of potassium sorbate (SÁNCHEZ PASCUA et al., 1994b). At the same time, different concentrations of acetic acid were added. This process is shown in Figure 1 and the physico-chemical characteristics of the intermediate moisture fish paste without acid are presented in Table 1.

To determine the maximum sensorially accepted acidity, the results of acetic acid content in the fillet of anchovy (*Engraulis anchoita*) obtained by Yeannes and Casales (1995) in marinated process were taken into account. According to the aforementioned, the amount of acetic acid added to the fish paste was: 0.2; 0.4; 0.6; 0.8; 1.0 and 1.5% w/w.

2.2 Chemical and physical analyses

Determinations of pH were carried out on raw material, on fish paste prior to the incorporation of acid and on fish pastes with different acid contents. The pH was measured by a pH-meter with a glass electrode (Parsec model Vega IV) in a homogenate 1:1 of 10 g of sample and water according to AOAC Sec. 981.12 (1990). In the base paste, the a_w was gravimetrically determined (SÁNCHEZ PASCUA et al., 1994a). Water content

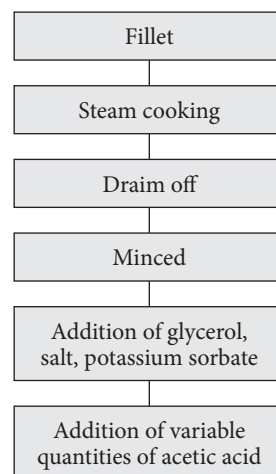


Figure 1. Process of elaboration of the fish paste.

Table 1. Physico-chemical characteristics of the fish paste without acid.

Sample	Water content g.100 g ⁻¹	Lipids g.100 g ⁻¹	ClNa g.100 g ⁻¹	Glycerol g.100 g ⁻¹	pH	a_w
Fish paste without acid	58.02	2.29	1.5	17	6.8	0.915

was determined drying 5 g of sample in an oven with a sulfuric acid atmosphere (FAVETTO et al., 1979).

Lipids were determined using the acid hydrolysis method. The results were expressed as g.100 g⁻¹ of paste according to AOAC Sec. 922.06 (1990).

2.3 Sensorial evaluation

The sensorial tests were carried out by six trained panelists and selected by their ability in recognizing basic tastes. They were trained by means of matching, detection, discrimination and ranking tests to determine the ability to discriminate levels of intensity of basic tastes (sweet, sour, bitter, salty, umami) (MEILGAARD et al. 1996; IRAM 1996). Taking into account the characteristics of this product the sweet taste provided by glycerol at used concentrations and acid taste provided by acetic acid were assessed.

The questionnaires for each test were designed according to standardized patterns (PEDRERO; PANGBORN, 1989; ANZALDÚA MORALES, 1994, MEILGAARD et al. 1996), and samples were always presented in the same way. This uniformity included portion quantity, temperature (21 ± 1 °C.), recipients and utensils. A table of aleatory numbers was used to codify the samples (ICMSF, 1981).

2.4 Test sequence

The following sequence of tests was carried out: Difference Tests (paired comparison test), Ranking Test, Scaling Test (using structured verbal scales), and for acid attribute, a Psychophysical Test (magnitude estimation) was chosen.

Paired comparison test

The Paired Comparison test was used by comparing perceptible differences in sweet and acid tastes among samples. To check if the judges could perceive differences in sweet and acid tastes, pairs of samples with 17% glycerol and the following acid concentration were tested: 0.4 versus 0.8% and 0.6 versus 1%.

Ranking test

Subsequently, the Ranking Test was used to grade samples from lower to higher values, according to the intensity levels perceived for both sweetness and acidity. Four samples in random order with 17% glycerol and with different acid concentration (from 0.2 to 1.5%) were evaluated in each test.

Verbal structured scale

Verbal structured scales with six intervals were used to qualify the perceived intensity for both acid and sweet tastes, with the extremes of each scale being nothing, and extremely acid/sweet. Samples with constant glycerol concentration (17%) and acid concentration variable were used (from 0.2 to 1%) Four samples indicating the testing order were assessed in each session.

Magnitude estimation

In order to estimate the magnitude of perceptible differences in the acid taste and to determine the possible sweet-acid interaction, a psychophysical method was applied assigning a value to the intensity perceived. The tasting order was indicated beforehand. For this test four codified samples were evaluated in each session. An arbitrary value was assigned to the first sample (reference sample) so that panelists could assign the other samples, a superior or inferior value in relation to that of the reference, and according to the intensity of the perceived acid taste. This test was used in pastes with 17% glycerol and different percentages of acid, and in pastes containing only acid in the same percentages.

With this sequence of tests the sweet-acid interaction and its effect on the taste of the product were determined.

3 Results and discussion

The characteristics of the paste without acid and the pH of pastes with different percentages of acid are shown in Tables 1 and 2.

The results of paired comparison tests showed that significant perceptible differences ($p < 0.001$) existed among samples with changes in acid concentration of 0.4 units. As much as 89.47% of panelists indicated those samples containing a less acid concentration as sweeter.

In the ranking test the acid content was correctly ordered by 95% of the judges and for the sweet taste 83.3% of the judges also ordered the samples, although glycerol concentration remained constant. The sample with the lowest acid content was perceived as sweeter. The aforementioned would indicate a modification in the perception of sweetness of glycerol by increasing acid levels. These results agree with those obtained by Pangborn

and Chrip (1964); Pangborn and Trabue (1964); Schifferstein and Frijters (1990); Bonnans and Noble (1993); Marsh et al. (2003); Marsh et al. (2006) in fruits, fruit juices and fruit pulps containing citric acid and sucrose, showing the lack of this type of information in fish products.

Sweet and acid tastes perceived in fish pastes with different acid concentration are shown in Figure 2. The results obtained with structured scales indicated that samples with 1% acid were significantly more acid ($p < 0.01$) than the rest, and those with 0.8% concentration were significantly different ($p < 0.01$) from samples with 0.2 and 0.4% acid concentration. No differences in acid perception were detected among the following sample couples: 0.8 and 0.6%; 0.6 and 0.4%; 0.6 and 0.2%, and 0.2 and 0.4% acid concentrations. The fact that the sample with 0.2% concentration significantly differed ($p < 0.01$) from the rest was determined in the sweet taste evaluation. Significant differences between 0.6 and 0.4%; 0.8 and 0.4%; 0.6 and 1%, and 0.8 and 1% acid concentration were determined, but no differences between 0.6 and 0.8% acid concentration were detected.

Steven's law was used to obtain relationships between the perceived sensation (S) and the variations in the concentration of the stimulus (C) (GUIRAO, 1980; BARBIERI et al. 1999; FISHER; SCOTT, 2000) (Equation 1):

$$\log S = \log K + n \log C \quad (1)$$

S being, sensorial perception; K, constant; C, concentration of the stimulus (acid); n, exponent of Steven's law.

Table 2. pH values of fish pastes with different concentrations of acid.

Acid g.100 g ⁻¹	0.2%	0.4%	0.6%	0.8%	1%	1.5%
pH	6.1	5.8	5.5	5.25	5	4.7

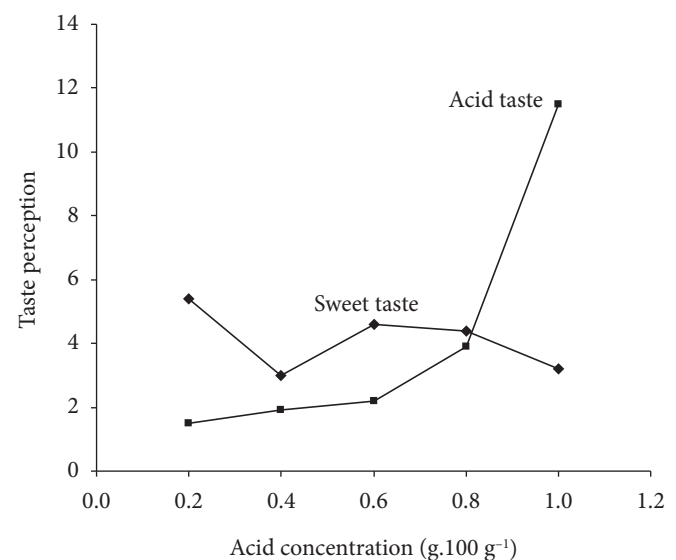


Figure 2. Sensorial perception of sweet and acid tastes from verbal structured scales in samples with constant glycerol concentration and variable acid concentration.

Fish Paste without glycerol (Equation 2):

$$\text{Log } S = 1.752 \times \text{Log } C_{\text{acid}} + 1.154 \quad (r = 0.958) \quad (2)$$

Fish Paste with 17% of glycerol with different concentrations of acid (Equation 3):

$$\text{Log } S = 1.208 \times \text{Log } C_{\text{acid}} + 1.167 \quad (r = 0.912) \quad (3)$$

The values of coefficients in Equations 2 and 3 are higher than the unit and they agree with those obtained by several authors for other gustatory stimulus (GUIRAO, 1980). The coefficient of the equation for the fish paste without glycerol was higher than the fish paste with 17% glycerol which would indicate that the sweet taste of the glycerol diminished the intensity of the acid stimulus. The higher correlation coefficient in Equation 2 indicates that panelists proceed to a much easier discrimination when the influence of the sweet taste is not present.

4 Conclusions

The combination glycerol-acetic acid exhibited a mutual reduction effect on perception of sweet and acid tastes. This subject has not been analyzed until now in fish products from this point of view.

The high correlation coefficient obtained with Steven's equation indicates that functionality exists between the psychophysical magnitude of the acid taste and the physical concentration.

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