IN VITRO ANALYSIS OF ORTHODONTICS ELASTICS IN ACID AND IN BASIC ACQUOUS SOLUTIONS

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Abstract. *In Orthodontia the use of elastics and elastomeric by orthodontists has become routine. Techniques have been receiving improvements and getting perfected with the introduction of devices that allow controlled movement of dental elements. Mechanic properties of elastics are not well defined and suffer the influence of factors inherent to the material such as loss of elasticity, influence of saliva, pH variety and diet. Facing an expressive commercial supply of elastics and a literature poor in practical studies, this study has strived to comparatively evaluate the deformation percentage of two types of orthodontic elastics of the TP ORTHODONTIC (imported) and UNIDEN (national) brands when submitted to dynamic tests of stretching three times their internal diameter in different humid environments. Twelve 5/16 inches samples of elastics of the light, medium and heavy types of the respective brands were selected randomly. Samples were placed in a simulated oral environment staying immersed in artificial saliva solutions with a 4.9 acid pH and a 7.2 neutral pH for two hours and later immersed in coffee (60°C) and Coke (8,5°C) for a minute. Images of the stretching of the elastics were taken and digitalized by the original web cam camera-software set at a rate of every 10 minutes in the first thirty minutes and later every 30 minutes for a maximum period of 120 minutes. Images were stored in a PC using the Image-Pro Plus software and underwent treatment for measurement of the generated deformation. Results allowed the conclusion that the elastics used showed a significant variation (7%) in the initial diameters with the exception of the heavy TP ORTHODONTIC elastic. At the end of the experiment in the two levels of pH the greatest average deformation percent was in the light TP ORTHODONTIC type (14% - 44%) while the least average deformation percent was in the medium UNIDEN type (6% - 11%). The elastics immersed in saliva pH 7,2 showed the greatest average deformation percent. Temperature and humidity had a significant effect in the elastics' deformation. Coffee (60ºC) increased the average deformation percent of the elastics (2% - 6%). The Coke (8,5°C) increased the average deformation percent of the elastics (0,5% - 4%). For a more precise measurement of deformations was used a simple low cost image acquisition and treatment system that allows analyse and the pós-process of the data without repeating all the mensuration procedures.*

Key words*: Orthodontics elastics, humid and temperature influences, Image Acquisition and Treatment System*

1. Introduction

Orthodontia is the branch of the dentistry that is interested in the study of the growth of the craniofacial complex, of the development of the occlusion and of the treatment of the dental and facial irregularities. The orthodontic treatment seeks the harmony among the teeth, lips and maxillaries bones taking to an appropriate facial balance, pleasant aesthetics and mastigatory physiologic function. The orthodontic correction is made through fixed and mobile appliances that mechanically promote the displacement of the dental elements and the adjacent structure for wanted positions. The appliances should promote a great force, in the minimum time, with maximum comfort and hygiene and minimum cost for the patient.

The orthodontics elastic are sufficiently use but their mechanical properties are not well characterized. Those properties are influenced by several inherent factors to the material (loss of elasticity, amount of dissipated force and composition of the material), environmental factors (the influence of the saliva, variations of the pH, temperature of the atmosphere, influence of the alimentary diet and pigments), besides effects of the mandibullary movements. (PROFFIT, et al., 1995; DE GENOVA, 1985)

The data of the literature don't provide uniform conclusions or even consent in what refers to the amount of the degradation of the force. There is great difficulty of comparison of those elastic ones due to variations in the method employee's nature and a great number of types of elastic existent in the market, having like this, a variation in the decrease degree in the magnitude of by force of agreement with the tested product (COLFELT, 1991This work has with

objective to show an experimental methodology for analysis in vitro of the deformations generated by static efforts, before and after cycling, of orthodontics elastics, using an image acquisition and treatment system of low cost and a opening and closing mouth simulation system accessible to any professional of the dentistry area. Three types of orthodontics elastics (light, medium and heavy), of two marks (national and imported) were analyzed. The influence of two levels of pH in artificial saliva was verified, as well as the influence of another environmental factors, such as: Coke and coffee, in the plastic deformation suffered by the elastic orthodontics.

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2. Methodology

The intra-oral orthodontics elastics were used in this research. They were intermaxillary of latex, colorless of two different commercial marks (national and imported). Twelve5/16 inches samples of elastics of the light, medium and heavy types of the respective bands were selected randomly. The elastic of the light type were divided in two groups of six samples for the loads of 58,8 cN and 78,5 cN, the one of the medium type for the load of 78,8 cN and 98,1 cN and the one of the heavy type for the load of 156,9 cN and 196,1 cN. For the generation of by force of traction in the elastic pré-defined loads were used. The patterns of force, generated by plastic bottles of 200ml, with covers varied between 19,62 cN to 196,2 cN. The water was chosen to make possible and a better load definition. For the production of the loads, a balance precision of resolution of 0,001grama was used. All the elastic were maintained in their original plastic packing before the test.

The measurement system for acquisition and image treatment in the visible was proposed for Oliveira, (2005), with uncertainty of mensuration of 0,2 mm. This system was created to reduce the dependence of the action of the operator, to guarantee larger reliability metrologic, operation easiness and low cost. The process of treatment of the image obeyed the methodology showed by Oliveira (2005) and used by DUARTE (2005).

The elastic was fastened in rigid hooks of inoxidable steel, contends braquetes soldiers in its extremities. One hooks was fixed to the lateral of a box of acrylic. In the other hook a thread of Nylon with 0,5 diameter mm and load of rupture of 118 N was fixed which the plastic bottle was hung.

The images were captured and digitalized for period of 10 in 10 minutes in the first thirty minutes and later every 30 in 30 minutes to a maximum period of 120minutos to mensuration of the deformation. Images were stored in the PC using the image Pro Plus software and underwent treatment for mensuration of the generated deformation. A first image with load of minimum traction was captured, generating an initial stretching of reference. That load of minimum traction was accomplished being used the empty plastic bottle of 200ml (12,7cN), being just for a geometric accommodation of the elastic.

For analysis of the elastic submitted to the cycling, it was used a system of simulation of the opening and closing movement of the mouth, proposed by OIVEIRA (2005).

The artificial saliva was used in the experiment was manipulated by PHARMACEUTICAL LENZA. The formula of the artificial saliva went to same elaborated by the LENZA pharmacy of UFRJ (Matta; Chevitarese, 1997) presenting the following basic composition: potassium chloride (0,96g), chloride of sodium (0,674g), chloride of magnesium (0,0408g), chloride of calcium (0,1168g), potassium bifosfato (2,74 g), ‘big’ sodic carboximetilcelulose 70D (8 g), sorbitol at 70% (24g), nipagin (1g), distilled water q.s.p. (1000ml), and that this formula was adjusted for the acid pH of 4,9 and for the basic pH of 7,2.

Initially the elastic orthodontics was submitted to a load of minimum traction, generating an initial stretching of reference. Immediately after this procedure, the elastic were positioned in the hooks of the braquetes staying submersed in artificial saliva, in such way that to the system operated, the axis virabrequim was worked made a recurrent movement in drop form, simulating the opening and closing of the mouth. In this movement the elastic stretched and they came back the initial position until to a maximum stretching of 40 mm.

The system was turned off for period of 10 in 10 minutes so that the elastic immersed in the saliva were retired and put in the braquetes hooks in the other box's acrylic. There they were submitted to the load of defined traction for each type (light, medium or heavy). The images were captured and digitalized and treated. The same procedure was accomplished in 30, 60, 90 and 120 minutes. At the end of the 120 minutes an evaluation of the deformation of the elastic was accomplished by means of the difference of the stretching happened in each interval of time.

After this procedure the elastic were immersed in a recipient contends Coke in the temperature of 8,5 °C, and/ or coffee in the temperature of approximately 60°C during a minute. The image was captured with the load of defined traction to quantify the influence of these substances in the elastic.

3. Results

The Table 1 shows the values, in millimeters, of the initial and last lengths, as well as the individual stretching of each sample along the time, of the orthodontic imported elastic light type immersed in saliva with pH 4,9, when submitted the load 58,8 cN.

Table 1 - Deformation of the imported elastic light type, pH 4,9 saliva - load 58,8 cN

		Samples / Lenght (mm)							
		1ª	2ª	3ª	4ª	5°	6°	average	standard
Initial load 12,7cN		14,7	14,8	14,8	14,6	14,7	14,6	14,7	0,10
Last load 12,7cN		16,5	16,4	16,7	16,7	16,4	16,2	16,5	0,20
Load (cN)	Time (min)								
58,8	10	14,6	13,9	13,9	15,3	14,0	14,1	14,3	0,55
58,8	20	15,0	14,6	14,6	15,5	14,8	15,0	14,9	0,35
58,8	30	15,3	14,8	14,8	15,7	15,0	15,3	15,21	0,35
58,8	60	15,7	15,3	15,7	16,2	15,6	15,5	15,7	0,32
58,8	90	16,0	15,5	16,0	16,5	15,9	15,7	15,9	0,33
58,8	120	17,1	16,4	16,7	17,6	16,3	15,9	16,7	0,60
58,8	Coffee 1’	17,5	16,8	16,9				17,1	0,35
58,8	Coke 1’				17,9	16,7	16,2	16,9	0,88

The illustrations 1 to 12 shows the behavior of the orthodontics elastics imported and national when submitted to dynamic tests with artificial saliva pH 4,9 for 120 minutes. After that period some elastics were also immersed for one minute in coffee (60°C) and/or Coke (8,5°C).

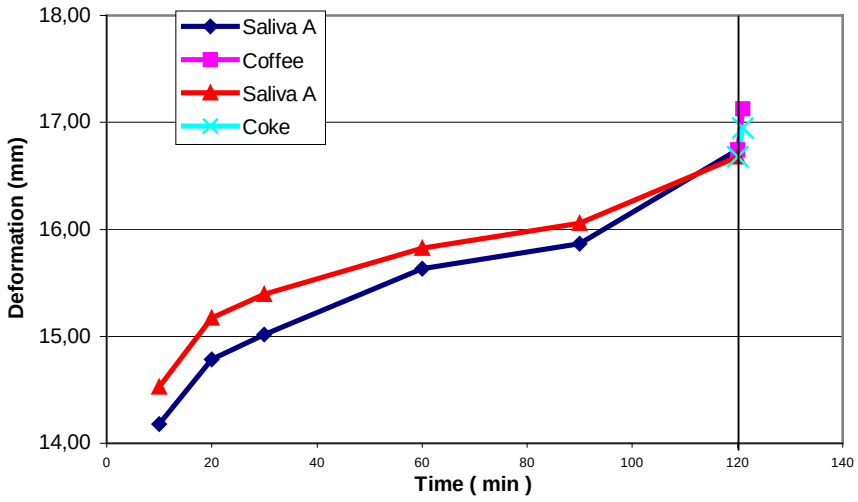

Figure 1. Deformation of the imported elastic light type, pH 4,9 saliva - load 58,8 cN

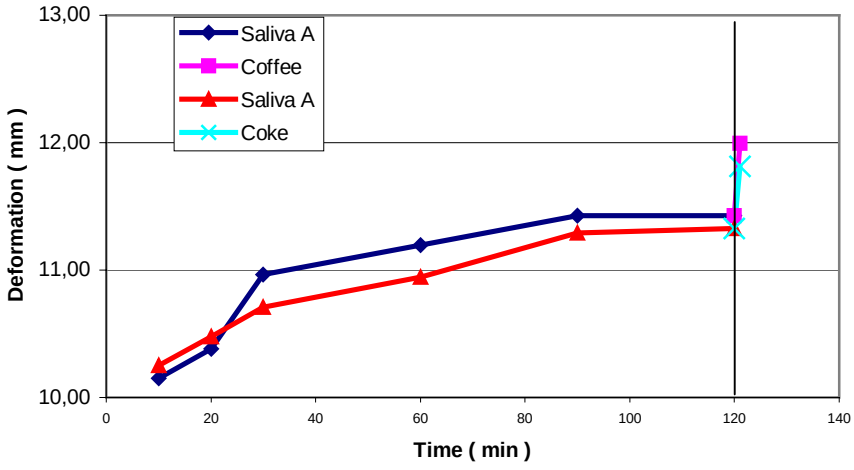

Figure 2. Deformation of the national elastic light type, pH 4,9 saliva - load 58,8 cN

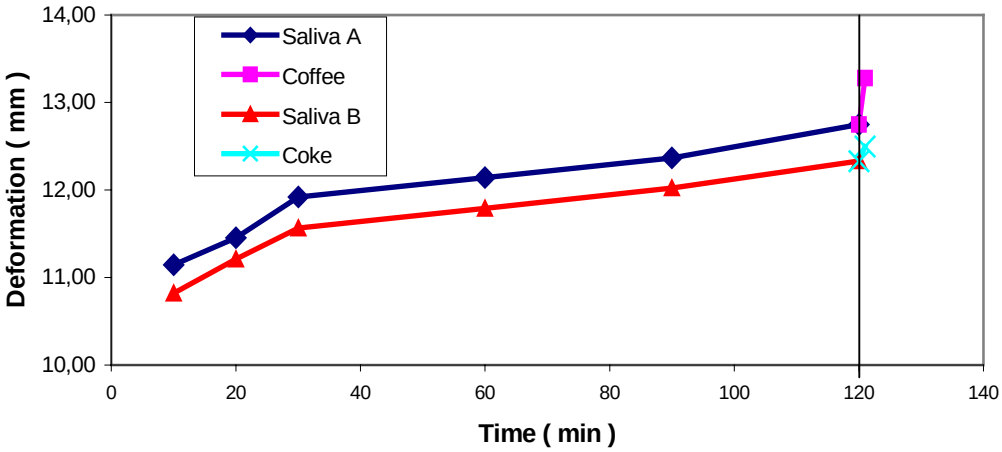

Figure 3 Deformation of the imported elastic medium type, pH 4,9 saliva - load 78,5 cN

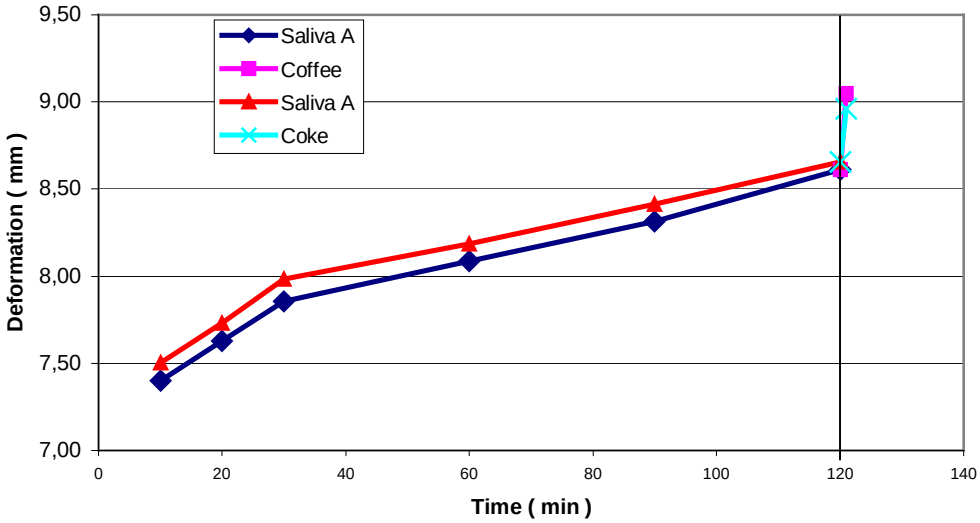

Figure 4- Deformation of the national elastic medium type, pH 4,9 saliva - load 98,07 cN

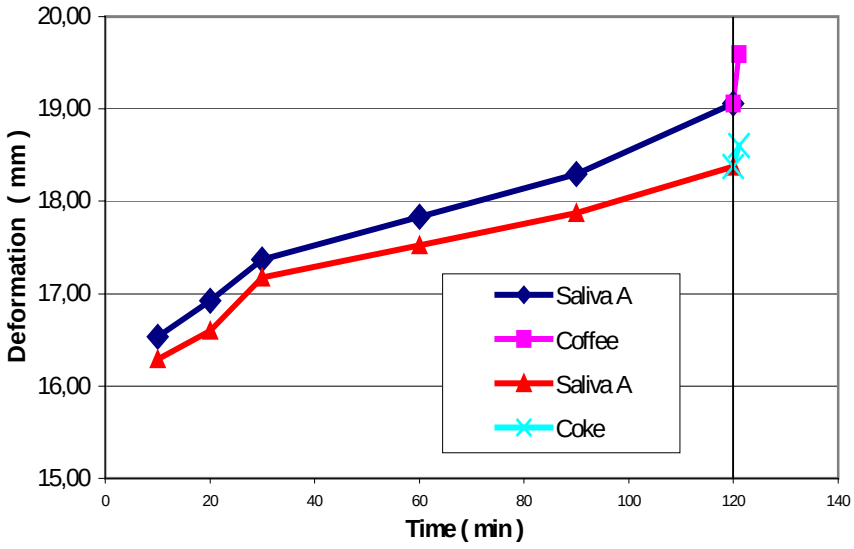

Figure 5 - Deformation of the imported elastic heavy type, pH 4,9 saliva - load 196,13 cN

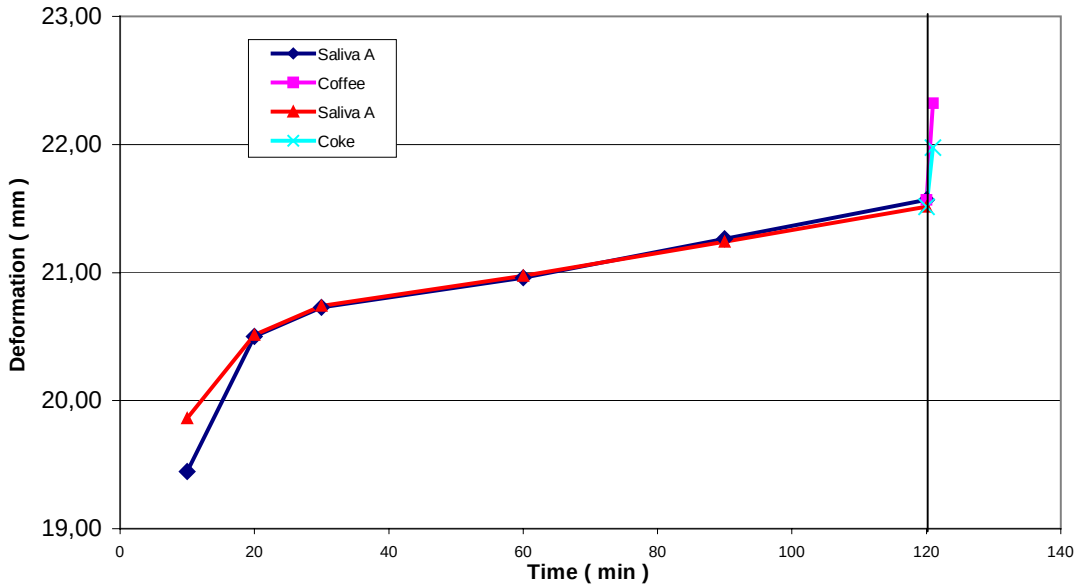

Figure 6 - Deformation of the national elastic heavy type, pH 4,9 saliva - load 196,13 cN

After comparative analysis among the three types of elastic, imported and national, when immersed in saliva pH 4,9, was verified that the elastics of the illustrations 1, 4 and 5 showed the greatest deformation. The Figures 7 to 12 present the behavior of the orthodontics imported and national elastics when submitted to the dynamic test with artificial saliva pH 7,2, for 120 minutes. After that period the elastic were also immersed for a minute in coffee (60°C) and/or Coke (8,5°C).

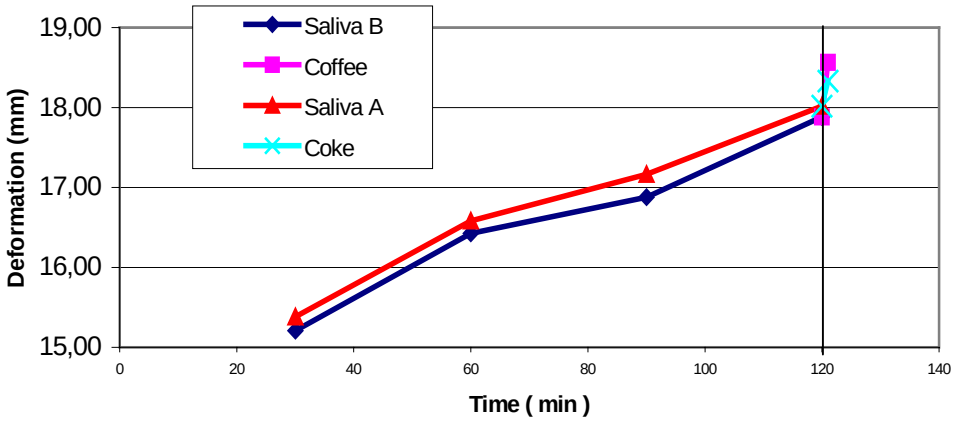

Figure 7 - Deformation of the imported elastic light type, pH 7,2 saliva - load 58,8 cN

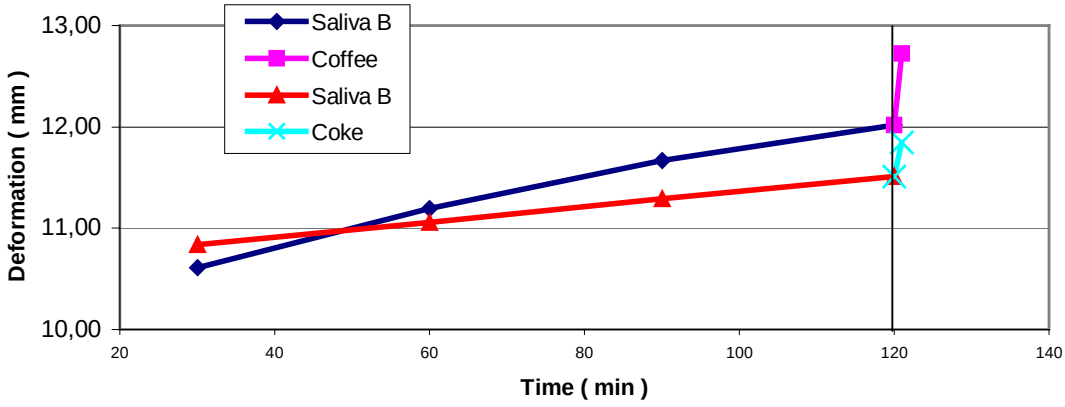

Figure 8 - Deformation of the national elastic light type, pH 7,2 saliva - load 58,8 cN

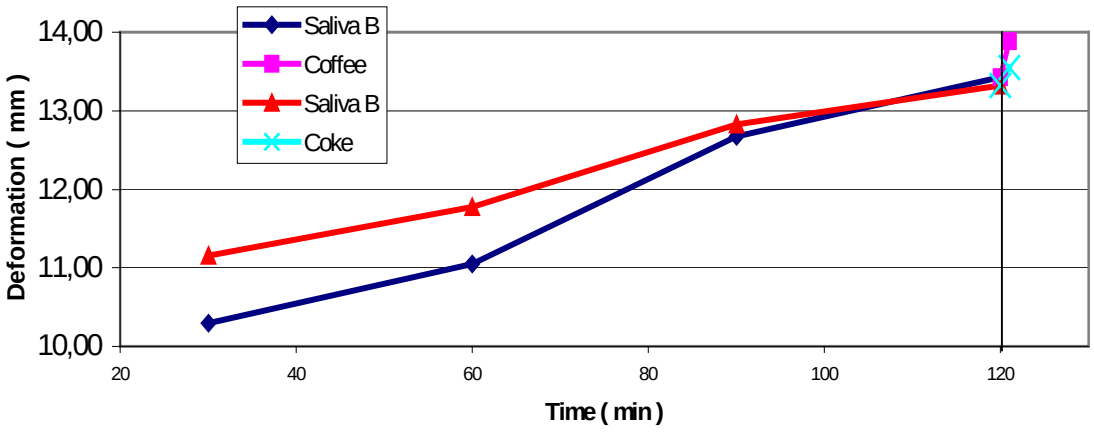

Figure 9 - Deformation of the imported elastic medium type, pH 7,2 saliva – load 78,5cN

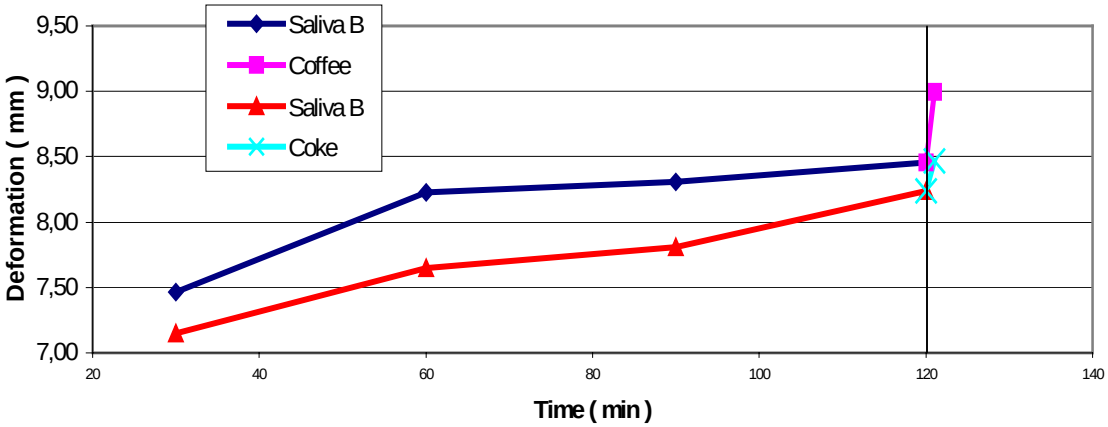

Figure 10 - Deformation of the national elastic medium type, pH 7,2 saliva - load 78,5cN

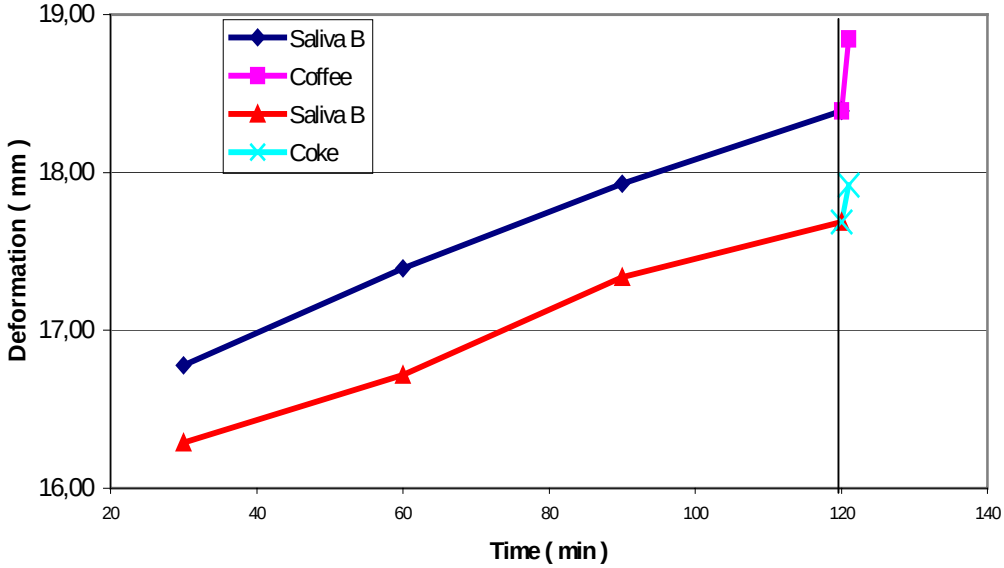

Figure 11 - Deformation of the imported elastic heavy type, pH 7,2 saliva - load 196,13 cN

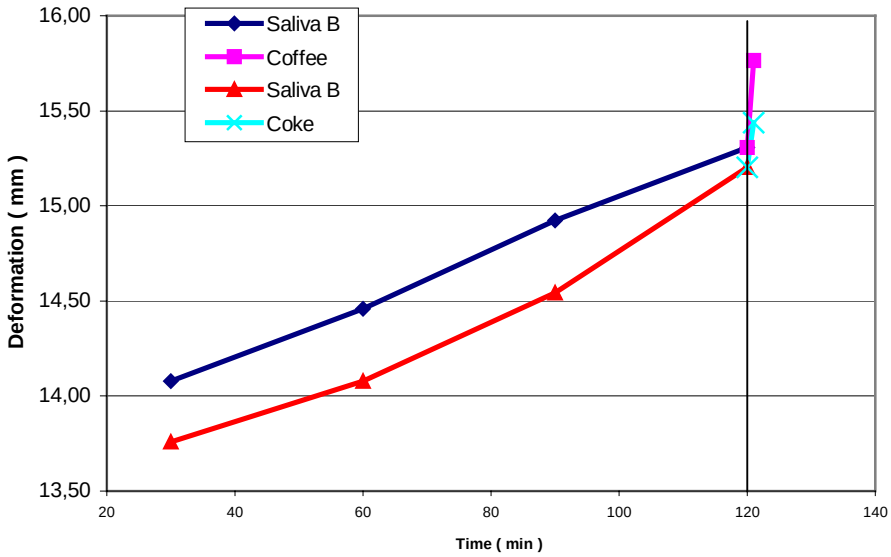

Figure 12 - Deformation of the national elastic heavy type, pH 7,2 saliva - load 196,13N

After comparative analysis among the three types of elastic, imported and national, when immersed in saliva pH 7,2 was verified that the elastic of the illustrations 7, 9 and 11 showed the greatest deformation.

In that research the elastic immersed in acid saliva pH had the smallest average deformation percent, corroborating with the discoveries of FERRITER et al. (1990).

3. Discussion

The elastomeric products loses action with the time, even in saliva basic pH or saliva acid ph and their properties are modified by the humidity. The net loss of experiencied by the elastic that functions in an aqueous enviroment shows the combined effects of stress relaxation and load- requirement redution. Some authors affirm that during the first hour happens the largest loss in the capacity of liberation of the force and this happened in this study. Elastic maintained in saliva acid pH showed smaller degradation of the force at the end of the time of observation..

4. Conclusions

A methodology was proposed for simulation for analysis experimental in vitro of the deformations generated by static efforts before and after cycling of elastic orthodontics. Elastic intraoraly and intermaxillary of latex were analyzed of the national and imported model of the types light medium and heavy. The influence of two levels of pH of artificial saliva was verified as well as the influence of another environmental factors such as: Coke and coffee in the plastic deformation suffered by the orthodontics elastics.

The system based on acquisition and image treatment was efficient for the mensuration of the deformations of the elastic so that the component mensuration uncertainty showed by the system was 0,2 mm, while the component uncertainty to the variability of the material was 0,6 to 2,6mm.

The elastics used showed a maximum variation of 7% in the initial diameters, characterizing a flaw in the standardization. The imported elastic heavy type, were the ones that showed better initial standardization, with deformation varying up to 4%. The light type elastics were the ones that had average deformation percent more elevated in the two pH levels, from 14% to 40%. The national heavy type elastic showed average deformation percents smaller in the two pH levels, varying from 6% to 11%.

With relationship to the influence of the pH of the saliva in the degradation of forces was observed significant differences in the two types of elastic, and the largest deformation was of 44% in the pH 7,2. All the elastics used showed considerable degradation tension in function of the time with average deformation percent varying from 2,3% to 44 % depending on the elastic type and level of pH of the saliva that the elastics were immersed.

The temperature and the humidity had significant effect in the deformations of the elastic. The coffee (60ºC) increased from 2% to 6% average deformation percent of the elastic. The Coke (8,5ºC) increased from 0,5% to 4% the average deformation percent of the elastic.

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