MULTIPLE TIME-INTENSITY ANALYSIS: SWEETNESS, BITTERNESS, CHOCOLATE FLAVOR AND MELTING RATE OF MILK CHOCOLATE WITH SUCRALOSE, REBAUDIOSIDE AND NEOTAME IN EQUI-SWEETNESS

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INTRODUCTION

Considered as a worldwide epidemic, obesity occurs independently of economic and social conditions, and has shown a significant increase in the last 20 years. However it would be difficult to explain this fact based on genetic changes occurring in this space of time. Thus the main mechanisms involved in the development of obesity have been related to environmental factors, such as inadequate eating habits and reductions in daily caloric expenditure. The objective of research was to compare the dynamic sensory profile (Multiple Time-Intensity Analysis - MTIA) of milk chocolate formulated with different sweeteners.

METHODOLOGY

• Chocolate samples: Eight samples were studied. Four different milk chocolates were prepared - a traditional one (sweetened only with sucrose) and three other samples, differing only with respect to their sweetener: Sucralose (SPLENDA Micronized Powder, Johnson and Johnson), Rebaudioside (Enliten® 300000, Corn Products) and Neotame (SweetMix). The sucrose of the diet chocolates was replaced by Polydextrose (Litesse ®, Danisco) and Erythritol (Zerose 16961, Cargill) (17:26) as bulking agents, and the three high intensity sweeteners. Four samples of chocolate were prepared with soy extract, to replace to dry milk. In this formulations was used soy extract (Provesol PC, Olvebra) and the sweetners was the same.

•Judges: Twelve trained and selected judges (validation of training by values of significant Fsample ($p<0.30$) and non-significant Frepetition ($p>0.05$) in relation to each curves parameters) determined the dynamic profile of sweetness, bitterness, chocolate flavor and melting rate.

• Sensory analysis: MITA tested four sweetness, bitterness, chocolate flavor and melting rate evaluating them in separate instances with an intensity reference for each attribute. The assessors evaluated the samples with three repetitions using the software according to the time for each parameter. The collected curve parameters were statistically analyzed by ANOVA, Tukey´s Tests and PCA. The samples were evaluated individually but their results being analyzed simultaneously TI tests were performed for each parameter . The data collected during each sensory evaluation session and furnished the following parameters in relation to each stimulus: Imax (maximum intensity recorded by the tester); Timax (time in which the maximum intensity was recorded); Area (area of time curve x intensity) and Ttot (total time of duration of stimulus).

RESULTS AND DISCUSSION

- The substitution of sucrose by sucralose was shown to be the most effective, since it was closest to that of traditional milk chocolate with sucrose (MSU) and milk chocolate with sucralose (MSL). The soy-based diet chocolates were characterized by the vector Timax, which showed the longest time between placing the product in the mouth and complete melting. The stimuli of sweet taste and chocolate flavor showed similar behavior as a function of time, providing the desired sensation for this type of product. The bitterness showed a little accentuated profile in relation to the other stimuli, clearly visible in the case of the milk chocolates. However this behavior was different for the soy-based chocolates, which were characterized by bitterness. Melting in the mouth started soon after the peaks of maximum intensity for the other stimuli, showing a curve sloping to the right. Nevertheless the soy-based chocolates maintained profiles similar to those of the milk chocolates, providing positive results with respect to the substitution of this ingredient, as a function of providing creaminess and aiding in melting during chewing. The chocolates sweetened with sucralose were found in positions close to each other, showing similarities both in a dairy medium and with a vegetable base, such as soybean extract.

Table 1. Results of sweetness TI parameter

	Timax	Imax	Ttot	Area
MSU	24,41^{cd}	7,02^{a}	46,55^{d}	199,99^{a}
MSL	27,02^{b}	6,34^{bc}	52,08^{abc}	180,58^{abc}
MRE	29,43^{a}	6,04^{cd}	53,82^{ab}	181,86^{abc}
MNE	23,49^{d}	6,65^{ab}	45,32^{d}	201,73^{a}
SSU	24,05^{cd}	5,48^{e}	49,84^{c}	155,68^{d}
SSL	24,28^{cd}	6,58^{b}	50,36^{c}	188,86^{ab}
SRE	25,12^{bcd}	6,70^{ab}	51,10^{bc}	176,98^{bcd}
SNE	25,73^{bc}	5,86^{de}	54,33^{a}	164,66^{cd}
MDS	2,01	0,40	3,02	21,97

Table 2. Results of chocolate flavor TI parameter

	Timax	Imax	Ttot	Area
MSU	23,78^{a}	6,75^{a}	48,77^{ab}	157,42^{a}
MSL	23,31^{a}	5,60^{b}	48,29^{abc}	134,79^{bcd}
MRE	23,84^{a}	6,36^{a}	47,12^{abc}	149,43^{ab}
MNE	25,33^{a}	5,49^{bc}	49,52^{ab}	129,69^{cde}
SSU	24,60^{a}	4,71^{d}	46,29^{bc}	116,40^{de}
SSL	22,91^{a}	5,04^{cd}	49,93^{a}	123,48^{cde}
SRE	24,89^{a}	5,46^{bc}	50,28^{a}	136,77^{bc}
SNE	23,13^{a}	4,85^{d}	44,78^{c}	114,58^{e}
MDS	2,46	0,53	3,59	19,36

Table 3. Results of bitternesss TI parameter

	Timax	Imax	Ttot	Area
LSA	23,52^{b}	2,24^{e}	45,88^{cd}	69,74^{d}
LSU	27,07^{a}	3,02^{d}	46,01^{cd}	74,83^{d}
LRE	25,77^{ab}	4,30^{c}	50,79^{b}	123,36^{bc}
LNE	27,50^{a}	3,33^{d}	50,30^{Bc}	78,41^{d}
SSA	25,36^{ab}	4,09^{c}	48,51^{bcd}	119,79^{c}
SSU	23,22^{b}	5,12^{b}	47,39^{cd}	146,58^{b}
SER	23,99^{b}	6,29^{a}	54,20^{a}	208,54^{a}
SNE	19,74^{c}	6,50^{a}	54,87^{a}	221,79^{a}
MDS	2,97	0,64	2,97	24,96

Table 4. Results of melting rateTI parameter

	Timax	Imax	Ttot	Area
LSA	34,68^{b}	8,30^{a}	44,27^{ab}	136,05^{ab}
LSU	36,70^{ab}	7,50^{abc}	46,83^{ab}	139,47^{ab}
LRE	35,96^{b}	7,82^{ab}	42,97^{b}	141,65^{ab}
LNE	37,37^{ab}	7,83^{ab}	46,04^{ab}	153,93^{a}
SSA	34,86^{b}	6,36^{d}	43,89^{ab}	117,99^{b}
SSU	38,42^{ab}	7,27^{bc}	48,41^{a}	132,64^{ab}
SER	39,51^{a}	6,86^{cd}	46,50^{ab}	138,79^{ab}
SNE	37,84^{ab}	6,85^{cd}	47,71^{ab}	129,62^{ab}
MDS	4,25	0,81	4,94	29,43

LSA =MILK CHOCOLATE / SUCROSE
LSU =MILK CHOCOLATE / SUCRALOSE
LRE =MILK CHOCOLATE / REBAUDIOSIDE
LNE ="MILK CHOCOLATE / NEOTAME

SSA =SOY CHOCOLATE / SUCROSE
SSU =SOY CHOCOLATE / SUCRALOSE
SRE =SOY CHOCOLATE / REBAUDIOSIDE
SNE =SOY CHOCOLATE / NEOTAME

Means with a same letter in the same column do not differ significantly ($p<0.05$)
MDS: minimum significantly difference in according *Tukey test* ($p\leq0.05$).

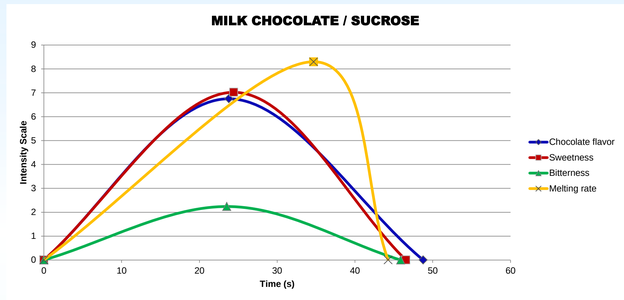

FIGURE 1. MULTIPLE TIME INTENSITY PROFILE OF MILK CHOCOLATE SWEETENED WITH SUCROSE

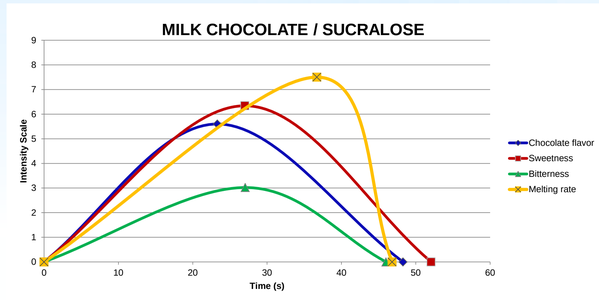

FIGURE 2. MULTIPLE TIME INTENSITY PROFILE OF MILK CHOCOLATE SWEETENED WITH SUCRALOSE

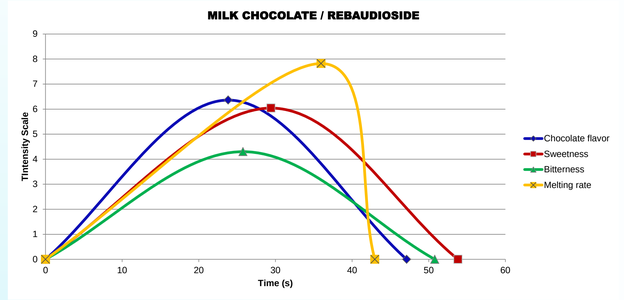

FIGURE 3. MULTIPLE TIME INTENSITY PROFILE OF MILK CHOCOLATE SWEETENED WITH REBAUDIOSIDE

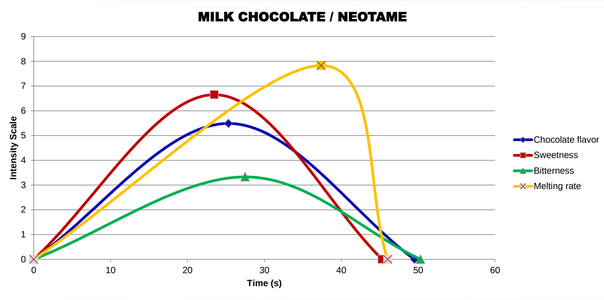

FIGURE 4. MULTIPLE TIME INTENSITY OF PROFILE MILK CHOCOLATE SWEETENED WITH NEOTAME

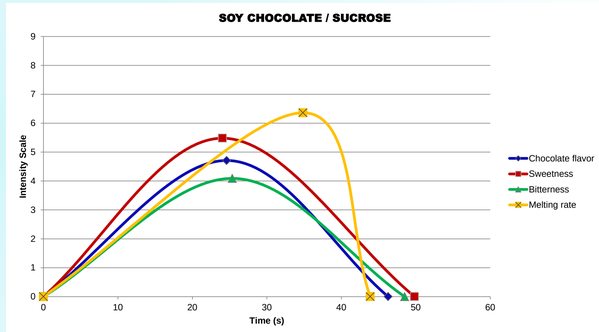

FIGURE 5. MULTIPLE TIME INTENSITY PROFILE OF SOY CHOCOLATE SWEETENED WITH SUCROSE

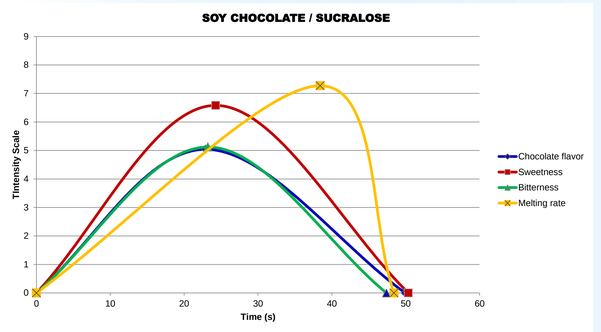

FIGURE 6 MULTIPLE TIME INTENSITY PROFILE OF SOY CHOCOLATE SWEETENED WITH SUCRALOSE

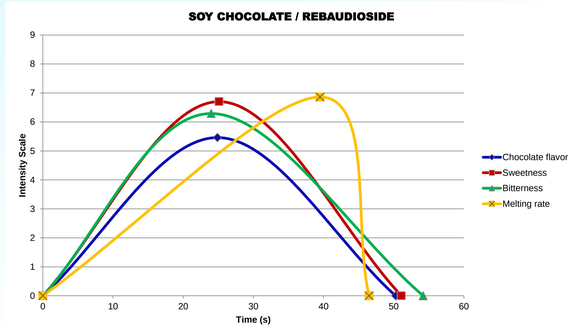

FIGURE 7. MULTIPLE TIME INTENSITY PROFILE OF SOY CHOCOLATE SWEETENED WITH REBAUDIOSIDE

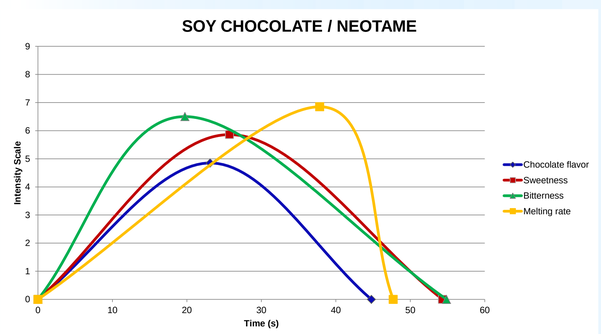

FIGURE 8 MULTIPLE TIME INTENSITY PROFILE OF SOY CHOCOLATE SWEETENED WITH NEOTAME

CONCLUSIONS

Neotame presented distinct results when comparing its use in milk chocolates with that in soy-based chocolates, its intensity being greater than the stimuli of sweet taste and chocolate flavor in the samples containing soybean extract. However in the milk chocolates it provided sensory stimuli significantly similar to those sweetened with sucrose. With respect to rebaudioside, there was an increase in the intensity of bitterness in relation to traditional chocolate, and a displacement of the sweetness curve in relation to that of chocolate flavor. There was an intensification of the chocolate flavor in the milk chocolate samples.

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