J. Mater. Environ. Sci. 7 (8) (2016) 3043-3049
ISSN : 2028-2508
CODEN: JMESC

The Evaluation of the Consumption of Additives and their relationship to the Food Products in Morocco

N. Rhaiem*, H. Sedki, M. Youss, N. Chahboun and M. Ouhssine
Laboratory of Biotechnology, Environment and Quality, Faculty of Sciences, University Ibn Tofaïl, PO Box 133, 14000 Kenitra. Morocco.

Received 02 Apr 2016, Revised 22 Jun 2016, Accepted 25 Jun 2016
**Corresponding author. E-mail: Email: rnourd@gmail.com (N. Rhaiem); Phone: 0653703436*

Abstract
The mode of food products that is consumed in Kenitra has changed in the last decade due to the food products that are full of additives. These food products have become the dominant in supermarkets, and more consumed among students at schools. The result of this research that was conducted on a group of 517 packaged food products that were collected from baskets in the three public schools, and which takes two months, reveals that there are seven types of food products that are the dominant among students. These food products are: biscuits, sweets, chewing-gums, soft drinks, chocolates, chips, and dairy products. The same study was done through the Principal Component Analysis (PCA) and shows that every food product is associated with certain group of additives. Moreover, the result shows that some food products contain a lot of additives in compared with others. For example, biscuits contain 6 additives, whereas sweets contain 2 additives. The evaluation of the ADI (Acceptable Daily Intake) was done to show how much additives are consumed daily by every single student, and the statistical result was 4. 28 mg per day for elementary school students (E.S.S), 3.06 mg per day for secondary school students (S.S.S), and 2.14 mg per day for high school students (H.S.S).

Keywords: Food additives, Student, Food product, Consumer. PCA

1. Introduction

In recent years, the food habits have changed in Morocco. The Consumption of food products continues to increase in Moroccan society and particularly among young students. Consumers tend to look for food products that are characterized by attractive color, special flavor, long preservation and with a high calories [1]. These characteristics exist only in products that contain chemical elements. These chemical elements are named additives. Food products, which are considered to be the source of life, have become a reason of many health problems for man **[2].** Besides, it destroys food security. A large number of students in schools consume food products which are full of food a additive, that is why our study was carried out on 517 rubbish packaged food products that were collected from bins after finishing each break in the three public schools in Kenitra. There are three objectives in this study. The first objective is to examine the most consumed food products by students. The second aim of this study is to examine the relationship between every category of food product with different class of additives. The third objective is to evaluate the rate of consumption of these food additives according to the three groups of surveyed students.

2. Material and methods

This study was conducted in schools where there are many students, who consume these food products. The rubbish packaged food-products were collected for 15 days, and then they were categorized separately according to the nature of the food product. The food additives included in the labeling foodstuffs were written

in the Excel according to their category. Using statistical software PCA (Principal Component Analysis), we calculated the percentage of every single additive existing in different categories of the collected food products and the relationship between the two. Then we searched the food products containing a high rate of additives.
Finally, we evaluated the quantity of additives consumed by the students in the three schools through the most consumed food products. The determination of this ingestion rate (TNR) for these additives is calculated by using the following equation **[31]**:

$$D.A = \frac{\sum([F.A] \times Q\ (\text{food product}))}{\text{body weight (kg)}}$$

[F.A]: the concentration of the additive in the food product;
Q : the quantity of the food product consumed per day;
D.A : the dietary exposure
For body weight, the participants were divided into three groups according to age and grade/educational level. The first group consists of primary students at age 7 to 10 years. The second group includes middle school students at age 11 to 14 years, and the third group consists of secondary school students at age 15 to 18 years. All participants are weighed using a mechanical and portable scale (range 150 ± 1kg). The balance is calibrated and placed on a flat surface. The subjects were informed beforehand to wear minimal clothing without shoes. The measurements are reported in ´´Excel´´ to exit the average weight on each category.

3. Results and Discussion

Most of the participants said that they do not pay attention to what is written on the packaged food products. Rather, they pay attention only to colors, shapes and pictures. Moreover, 95% of the students said that they are not aware of the negative effects of the food additives consumption. Through the 517 rubbish packaged food products collected from the bins in the three schools, we have found 1297 of food additives. This reveals that every packaged food product contains at least 2 or 3 of additives. However, some packages contain 10 additives like biscuit as an example, while others contain only 1 or 2 additives such as sweets. Although they contain little food additives, they cause a lot of health problems **[4];** because this is related to the nature of the additive and the dose used by the consumer. In France 3-5% of children suffer from hyperactivity **[5]** because of the food additives consumption.

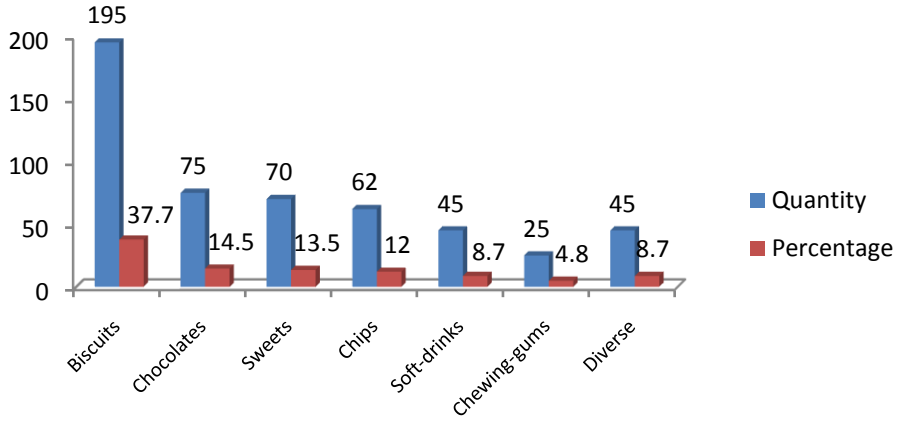


Figure 1: Distribution of packaging collected of different foods consumed by the population studied.

The result given in Figure 1 shows that students consume 37.7% of biscuits, 14.5% of chocolates, 13.5% of sweets, 12% of chips, 8.7% of soft drinks, and finally chewing gum (4.8%).
The biscuits are rich in additives; they contain 6 types of additives in each product. These additives are emulsifiers (57.56%); food acids (35.79%), thickeners (28.77%); baking powders with 84.24%; the preservatives with 55% and trans-fatty acid (56.73%). Sweets contain 3 additives as a high rate; they have 24.54% for food colourings, 23.44 % for sweeteners and 20.36% for food acids. As for chewing-gums, there are two dominant additives; sweeteners (23.44%) and food colourings (16.76%). Concerning chips, the dominant

additive is flavor enhancer (81.25%). Regarding soft drinks, the dominant additives are; antioxidant 27.27% and preservatives (23.75%). Chocolate is marked by the dominance of emulsifiers (26.93%). The preservatives are absent in chewing gums (1.25%), chips (2.5%) and dairy products (2.5%).

Table 1: Percentage of additives included in food products

Food additives	Food Products						
	Biscuits	Chewing-gums	Chocolates	Sweets	Chips	Soft drinks	Dairy products
Colouring	13.77	**16.76**	19.16	**24.54**	8.98	11.97	4.79
Emulsifier	**57.56**	1.47	**26.93**	7.75	1.84	4.06	0.36
Food acids	**35.79**	8.02	9.26	**20.36**	10.49	11.72	4.32
Thickener	**28.77**	10.96	16.43	17.80	4.10	16.43	**5.48**
Antioxidant	**22.72**	9	9	18.51	9	**27.27**	4.5
Baking powder	**84.24**	0.00	7.47	2.9	3.73	0.41	1.24
Sweetener	21.88	**23.44**	15.63	**23.44**	4.69	10.94	0.00
Preservative	**55**	1.25	6.25	8.75	2.5	**23.75**	2.5
Flavor Enhancer	3.12	3.12	6.24	3.12	**81.25**	**0.00**	3.12
Trans-fatty acid	**56. 73**	1.86	19,53	7.90	9.77	3.25	0.93

Biscuits are the richest in food additives, they contain the more food additives than the other products, and they have 6 varieties. The daily consumption of food products which are rich in additives such as biscuits, sweets, chewing gums and chips, causes many health problems for the future generations by the cumulative effect of food additives **[6].** The statistical analysis by PCA shows that there is a relationship between every category of product with specific additives. The projection of the products on the two axes 1 and 2 takes over 70% of the total variation (Figure 1), and shows two main groups.

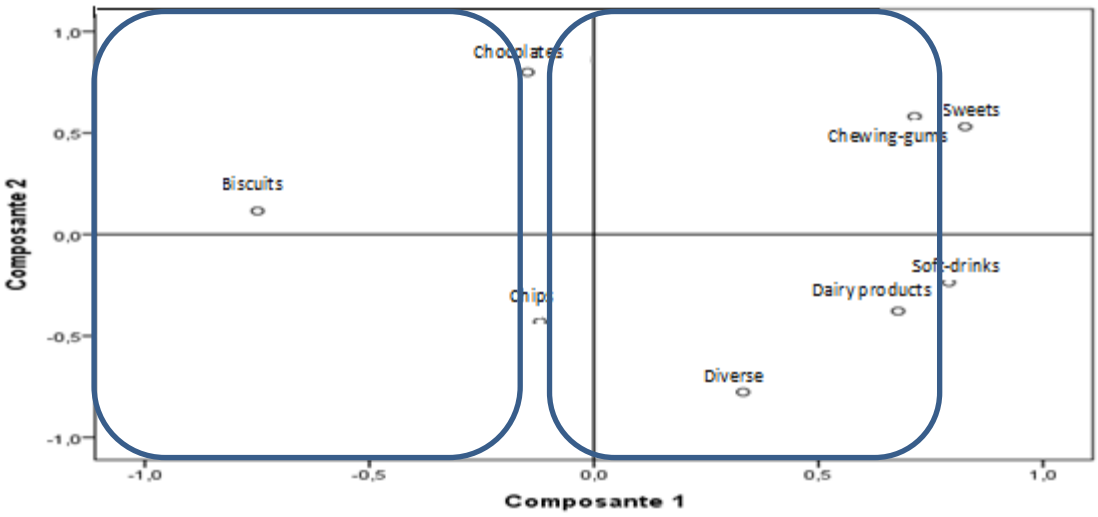


Figure 1: Projection of food on both axes 1 and 2

The first group consists of biscuits which are correlated to the negative side of axis 1 (-0.75). The second group consists primarily of foods like sweets (0.82), chewing gums (0.71), milk products (0.68) and soft drinks (0.79). The projection of additives corresponding to each product is shown in (Figure 2).

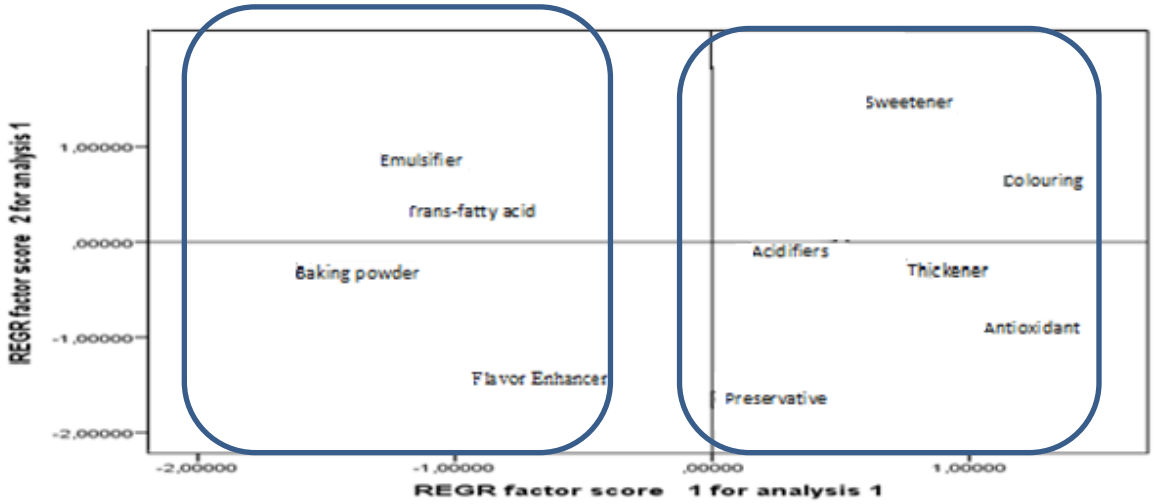


Figure 2: Projection of additives on both axes 1 and 2

The analysis shows a strong association between the food (sweets and chewing gums) and additives (food colourings and sweeteners), while dairy products and soft drinks are associated with antioxidants, thickeners and food acids. The biscuits are highly correlated with the following additives: emulsifiers, baking powders and trans-fatty acid. This association between food colourings and preservatives in biscuits and soft drinks lead to no concentration and hyperactivity to students **[7].**

3.1. Estimated daily intake of food additives among three groups of students

In this study, we looked for products with high levels of additives, especially those that contain harmful additives with their ADI and their effects on human health. Thus, 4 food products were selected; these are biscuits, sweets, chewing-gums and chips. The most used and controversial additives in each of these products are: aspartame (E951), which is used as a sweetener, and tartrazine (E102), which is used as a food colourings. These two additives were found in sweets and chewing gums. Chips are marked by the presence of monosodium glutamate (E621), which is a flavor enhancer. As for biscuits, they are rich in food additives, but these additives are not harmful to the human health Table 2.

Table 2: the most consumed food products, additives and their ADI

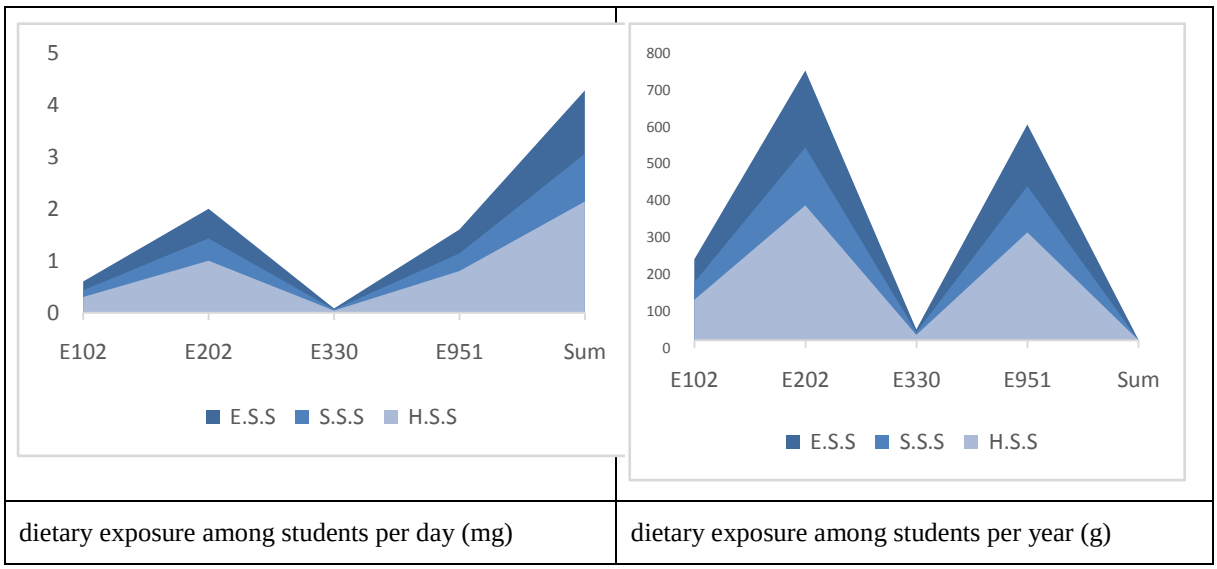
Food product	Name of F. A	Code of F. A	ADI (mg/kg)	Class of F. A	Effects on human health
Biscuits	Soy lecithin	E322	No limited	Emulsifier	
	Citric acid	E330	1	Food acids	Clastogenic properties (chromosomal aberrations) **[8].**
	Glycerine	E422	No limited	Thickener	
	Sodium bicarbonate	E500	No limited	Baking powder	
	Potassium sorbate	E202	0-25	Preservatave	Genotoxic **[9].**
	Ascorbic acid	E300	No limited	Antioxidant	
	Aspartame	E951	40	Sweetener	neurologic or behavioral reactions **[10].** neurological and behavioural disturbances,

Sweets					Headaches, insomnia **[11].** neurological problems, including learning and memory processes. **[12].**
	Tartrazine	E102	7.5	Colouring food	Hyperactivity **[13].**
	citric Acid	E330	1	Food acids	Clastogenic properties (chromosomal aberrations) **[8].**
	Glycerine	E422	No limited	Thickener	
Chewing-gums	Aspartame	E951	40	Sweetener	neurologic or behavioral reactions **[10].** neurological and behavioural disturbances, Headaches, insomnia **[11].** neurological problems, including learning and memory processes. **[12].**
	Tartrazine	E102	7.5	Colouring	Hyperactivity **[13].**
Chips	MSG	E621	No limited	Flavor enhancer	Oxidative stress. Allergy risk. Genotoxicity **[14]**

F.A: Food Additive
Dans les produits à fort taux de consummation et qui sont les chewing gums, les chip, les bonbons et les biscuits, nous avons trouvés dominance

3.2. Distribution of the most consumed food products, and additives with their ADI

To evaluate the danger of additives, we examined the quantity of the most additives consumed every day by every student. 4 products were selected in this study because they contain high degree of additives according to the table above such as biscuits (6 food additives), sweets (3 F.A), chewing-gums (2 F. A), and chips (2 F. A). These food additives are emulsifiers, food acids, thickeners, baking powders, preservatives, antioxidants, sweeteners and food colourings. The main dietary sources that expose the three groups of students surveyed to the risks associated with food additives represent 75% of contributions related to other products. Based on the results of the table (2), although biscuits are rich in food additives; it appears that sweets and chewing gums are the two products that expose students to risks related to food additives because they contain most doubtful like tartrazine (E102) **[15]** and aspartame (E951) **[16; 17].** The average weight for elementary school children is estimated to 25 kg, for the middle school students is 35 kg, and for secondary school students, the average weight is estimated to 50 kg. The amount of the consumed food product is estimated to be 1 unit of each product / day. The figure (3) shows the amount of additives consumed per day/per year and per group of surveyed students.



dietary exposure among students per day (mg) | dietary exposure among students per year (g)

E.S.S: Elementary School Children; S.S.S: Secondary School Students; H.S.S: High School Students.

Figure 3: The ADI estimated among Elementary school, Secondary and High school students

In this evaluation, flavorings, trans fatty acids and additives in which the ADI is not limited, like soy lecithin, MSG, sodium bicarbonate, ascorbic acid and glycerin, are not taken into account. The analysis of the graphs shows that elementary school children accumulate more food additives than secondary school students. And the ADI of secondary school students exceed those of high school students. Elementary students consume nearly 4.28 mg per day (1.56 g of Additives / year), followed by secondary school students 3.06 mg per day (1.11 g of additives / year). High school students are classified the latest with a rate of 2.14 mg per day (0.78 g of additives / year). The results that we found are far from those reported by Gouget **[18].** This latter declared in his book that the quantity of food additives eaten by French's children is 7 kg per year (19.2 g per day) **[19].** This deference can be explained by the fact that we have not considering the ADI of 6 other food additives, otherwise the results will be almost the same. Although the amount of food additives consumed by students is low, they are not protected from adverse effects, because the uncontrolled consumption of these products by their parent and the admiration of children towards these foods push them to consume these food additives abusively, which may constitute a favorable field for different food risks.
For chips, flavor enhancers, where monosodium glutamate (E621) is most dominant, represent 76.47% and they are very appreciated by the students. These additives cause harmful results to the students **[20].**

Conclusion

This article reports the student's consumption of additives existing in food products that take place in Kenitra, Morocco. Some of these products contain very dangerous food additives such as chewing gums and sweets which contain a high rate of two additives; aspartame (E951) and tartrazine (E102), which are known by their adverse effects on human health. Food products that contain lots of food additives are biscuits (6 additives / product on average). The recorded results also show that there is a strong relationship between some types of products with some types of additives. For example, colourings are dominant in sweets, sweeteners in chewing gums, thickeners in dairy products. While antioxidants and food acids, that are associated with soft-drinks. Emulsifiers, baking powder and fatty acid are attached to biscuits. Finally, the calculation of ADI additives that have determined values has shown that children ingest more additives than adolescents.

Reference

1. Story M, Nanney N .S, Schwartz M. B. Schools and Obesity Prevention: Creating School Environments and Policies to Promote Healthy Eating and Physical Activity. *The Milbank Quarterly*. 87 (2009) 71–100.
2. Schab D. W, Trinh N. H. Do artificial food colors promote hyperactivity in children with hyperactive syndromes a meta-analysis of double-blind placebo-controlled trials, *Journal of Developmental and Behavioral Pediatrics*, 25 (2004) 423-434.
3.Programme mixte FAO/OMS les normes alimentaires comité du codex sur les additifs alimentaires beijing, chine, (2013) 1- 43.
4. Hikmat and al., Examen des Réactions D'intolérance aux Aliments et aux Additifs Alimentaires, *International Food Risk Analysis Journal*, 1(2011) 25-36.
5. Bateman B., Warner J. O., Hutchinson E, Dean T, Rowlandson P., Gant C., Grundy J., Fitzgerald C., Stevenson J., The effects of a double blind, placebo controlled artificial food colorings and benzoate preservative challenge on hyperactivity in a general population sample of preschool children. *Archives of diseases in children*, 89 (2004) 506-511.
6. Hamrani. A., Estimation de la composition corporelle, des niveaux d'activité physique et des habitudes alimentaires chez l'adolescent Marocain Thèse Doctoral, Faculté des Sciences de Kénitra, (2012) 132.
7. Schab D. W., Trinh N. H. Do, Artificial Food Colors Promote Hyperactivity in Children with Hyperactive Syndromes? A Meta-Analysis of Double-Blind Placebo-Controlled Trials. *Developmental and Behavioral Pediatrics*, 25 (2004) 423-434.
8. Mamur S., Yüzbaşıoğlu D., Ünal F. and Yılmaz S., Does potassium sorbate induce genotoxic or mutagenic effects in lymphocytes? *Toxicology in Vitro*, 24 (2010) 790–794.

9. Yılmaz S, Ünal F, Yüzbaşıoğlu D and Aksoy H., Clastogenic effects of food additive citric acid in human peripheral lymphocytes. *Cytotechnology*, 56 (2008) 137–144.
10. Maher T. J. and Wurtman R. J., Possible neurologic effects of aspartame, a widely used food additive. *Environ Health Perspect*, 75 (1987) 53–57.
11. Humphries. P, E Pretorius. E and Naudé. H., Direct and indirect cellular effects of aspartame on the brain. *European Journal of Clinical Nutrition.*, 62 (2007) 451– 462.
12. Tsakiris S., Karantana A. G., Simintzi I. and Schulpis K. H., The effect of Aspartame metabolites on human erythrocyte membrane acetylcholinesterase activity; *Pharmacological Research.*, 53 (2006) 1–5.
13. Kamel. M. M, El-lethey. H. S., The Potential Health Hazard of Tartrazine and Levels of Hyperactivity, Anxiety-Like Symptoms, Depression and Anti-social behaviour in Rats. *Journal of American Science*, 7 (2011) 1211-1218.
14. Farombi E.O., Onyema O. O., Monosodium glutamate-induced oxidative damage and genotoxicity in the rat : modulatory role of vitamin C, vitamin E and quercetin . *Hum Exp Toxico.*, 25 (2006) 251-259.
15. Dutau G, Rancé F, Fejji S, Juchet A, Brémont F and Nouilhan P., Intolérance aux additifs alimentaires chez l'enfant : mythe ou réalité. *Rev. Fr. Allergol. Immunol. Clin.*, 36 (1996) 129-142.
16. Soffritti M., Belpoggi F, Degli Esposti D, Lambertini L, Tibaldi E, Rigano A. First experimental demonstration of the multipotential carcinogenic effects of aspartame administered in the feed to Sprague-Dawley rats. *Environ. Health Perspect*., 114 (2006) 379-383.
17. Blaylock R. L., Eoxins: The taste that kills. Santa Fe, NM: *Health Press*., 264 (1995).
18. Gouget. C., Additifs Alimentaires Danger. Le guide indispensable pour ne plus vous empoisonner. Escalquens : Ed. *Chariot d'or*., 157 (2012).
19. Gouget. C., Additifs alimentaires Danger, Le guide indispensable pour ne plus vous empoisonner, Ed. *Chariot d'or* ., 20 (2014).
20. Bourrier T., Intolérances et allergies aux colorants et additifs. *Rev. Fr. Allergol. Immunol. Clin*., 46 (2006) 68-79.