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# Food Additives Content in Selected Snack Foods and Beverages and Public Perception of E-Numbers in Muscat, Oman

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## Abstract

The aim of this study is to identify food additives content in selected snack foods and beverages sold in Omani market and if these additives could pose any health risk. Moreover, a pilot survey was also conducted to assess public perception regarding E-numbers used in these products. The E-numbers printed in the ingredient label of 83 products sold in different supermarket out lets and 250 questionnaires distributed to public were recorded, collected respectively and subsequently analyzed. The results showed that the overall number of food additives used in the selected crisps, biscuits and fruit juices was 46 in which 22 of these additives are found in crisps. Among these additives citric acid is the most common type and used frequently in all products. Some of the additives used such as monosodium glutamate and food colorings could pose a health risk upon excessive consumption. Lack of risk and benefit perception in the public regarding E-numbers is the main conclusion of the survey. Furthermore, significant ($p<0.05$) difference in knowledge and attitude between Omani and expatriates was also observed. The synergistic effect of food additives on health due to the excessive content of additives in the selected products needs more attention.

**Keywords:** adverse reactions, Chinese restaurant syndrome, E-numbers, food additives, hyperactivity

## Introduction

The use of food additives in food manufacturing has been a public health issue for many years (Haen 2014, Saltmarsh 2013). A report issued by the European Food Safety Authority (EFSA) in 2010 showed that 25% of people surveyed were "very worried" about food additives and a further 41% were "fairly worried" (EFSA 2010). Current research also suggests that consumers are worried and would like to be better informed about the potential health risks of food additive use and consumption (Bearth et al. 2014). Food additives of both natural and synthetic origin are introduced by food manufacturers into food products to serve a certain technological or sensory function and make them more marketable (Saltmarsh 2013). Therefore, food additives are claimed by many nutritionists to be an essential element in the spread of snaking culture as well as the commercial success of so-called junk foods, which are often held responsible, at least in part, in the increased prevalence of non-communicable diseases (Mepham 2011).

The use of food additives in food is well regulated by European and national authorities. The European Union (EU) legal definition of a food additive is as follows (Saltmarsh 2013):

> *"any substance not normally consumed as a food in itself and not normally used as a characteristic ingredient of food, whether or not it has nutritive value, the intentional addition of which to food for a technological purpose in the manufacture, processing, preparation, treatment, packaging, transport or storage of such food results, or may be reasonable expected to result, in it or its by-products becoming directly or indirectly a component of such food".*

Because food additives have become essential in the food industry, the European Economic Community (EEC) in 1988 introduced the regulation of labeling and numbering of food additives, such as food colorings, flavors, taste enhancers and preservatives, to promote a free and fair market of safe food products within the European Community (Haen 2014). Since then the E-number expression was used in the food’s ingredient label whereas "E" is for European safety approval. Within the European food legislative framework the approval of a substrate as a food additive is intended to both ensure the protection of public health regarding the use of food additives and inform consumers about their presence in food products (Saltmarsh 2013). Consumers have the right to make an informed choice about the food they consume and most additives are required to be declared on the food’s ingredient label as part of the ingredient list (Saltmarsh 2013). Preceding the approval of new food additives, intensive risk assessment usually based on animal studies, are undertaken and food additives already in use periodically re-evaluated. While a small amount of uncertainty on food additives’ potential harmfulness on humans cannot be ruled out, food safety experts generally agree on the reliability on this approach (Kokoski et al. 1990). It is therefore necessary for food manufacturers to make sure that the type and amount of a particular additive is suitable to use and does not exceed the acceptable safety limits specially for those people, who by nature of their diet, may consume high amounts of a particular food product such as children. Food additives are used in snack foods and beverages which are consumed heavily by children. Therefore, the aim of this study is to identify the food additives used in selected snack foods and beverages; crisps, biscuits and fruit juices, by recording and comparing their classification, purpose of use and the frequency of use in these selected products. This will help to link between these elements under investigation and the health risks associated with the use of food additives. Moreover, preliminary assessment of knowledge and perception of public towards E-number is going to be discussed.

## Methods

*E-Numbers Content of Selected Products*

Only products with E-numbers printed in the ingredient label were included in the study. A number of 83 products; 30 crisps, 28 biscuits, 25 fruit juices sold in different supermarket out lets across Muscat, the capital city of Sultanate of Oman, were recorded and their ingredient labels analyzed. The selection was based on brands (local; made in Oman, and international brands) that are widely sold in the supermarket out lets and affordable in terms of price for most families and popular, especially among children (Table 1).

*Pilot Survey on Public Perception of E-Numbers*

A cross sectional small-scale preliminary study (250 participants) was conducted using a questionnaire designed to assess the level of knowledge and attitude of the public reside in Muscat city towards E-numbers. The questions used are closed-end questions based on a study done by Bearth et al. (2014) and classified into two categories: demographic related questions like: gender, nationality, age and education and knowledge related questions like: how would you rank your knowledge about E-numbers which are used in foods? (very good, poor, I don’t know anything about it), the impact of E-numbers on health (may cause harm, good for us, depends on use, I have no idea), E-numbers used in foods can cause side effects and are responsible for many diseases? (yes, no, I don’t know), a product which contains more than one E-number could cause harm to health if consumed in large quantities? (yes, no, I don’t know), a product that contains attractive colors are not good for children? (yes, no, I don’t know), E-numbers are used in food products to make food taste delicious and look attractive? (yes, no, I don’t know). Questions related to attitude towards E-numbers were also included and are as follows: It is important to know what a food product contains, I buy a food product with clear and well defined ingredient labels, I can accept that a food product contains E-numbers, It is not important to check on the packaging whether a food product contains E-numbers and I pay attention during shopping that the food products I buy contain as much natural ingredients as possible.

The work was conducted in parallel and the data was collected for the E-numbers content of selected products and for the survey study during the period from February – August 2015 and subsequently analyzed.

*Statistical Analysis*

The data of the study were evaluated using SPSS 19.0 package program. The number of additives used in selected crisps, biscuits and fruit juices was compared using chi-square analysis. The knowledge and attitude between Omanis and expatriates were assessed using ANOVA and t-test. A criterion $p$ level of $<0.05$ was used to determine statistical significance.

## Results

*E-Numbers Content of Selected Products*

Food additives printed in the food's ingredient label of the 83 selected products were presented in one of the following formats: technical purpose (E-number); preservative (E211), chemical name (E-number); citric acid (E330) or only the additive name; Guar gum, the former is being the most commonly used. Some food manufacturers often prefer to use additive names wherever possible (taking account of the complexity of the chemical name and the limited room they may have on the label) and avoiding the use of E-numbers for reasons related to the negative consumer perception linked to the use of food additives.

In addition, the food's ingredient labels lack the information about the amounts of food additives besides the obvious use of more than one additive in most of the products. Large content of food additives is in crisps if compared with biscuits and fruit juices; 22, 11, 16 respectively (Table 1). This is can be explained by that crisps offer a large variety of forms; potato sticks, puffs, ripples and chips, as well as flavors; cheese, pizza, chilli, sour cream, ketchup, barbeque and vinegar. In all selected products, citric acid (E330) is the common content of food additives.

**Table 1.** *Brand Names (Local and International Products) of Crisps, Biscuits and Fruit Juices in Omani Market and the Food Additives (E-Numbers) Content in these Products. Citric Acid (E330) is a Common Additive in All these Products*

| | **Crisps (n = 30)** | **Biscuits (n = 28)** | **Fruit juices (n = 25)** | **Common E-number** |
|---|---|---|---|---|
| **Product brand name** | **Local (Omani):** Nabil (8 varieties), Suroor (2 varieties), Pofak Oman, Mudhish tortilla chips, Noora chips **International:** Cheetos (3 varieties), Lays (7 varieties), Pringles (2 varieties), Bugles (3 varieties), Doritos (2 varieties), Mister potatoes | **Local (Omani):** Nabil (7 wafer varieties), Nabile (7 biscuits varieties), Britania (2 biscuits varieties) **International:** Tiffany (2 biscuits varieties), Tiffany (5 wafer varieties) Dema, Nutro (3 biscuits varieties), McVities (2 biscuits varieties) | **Local (Omani):** A'Safwa (5 varieties), Top fruits (4 varieties) **International:** Original (3 varieties), Unikai (3 varieties), Almarai (5 varieties), Rani (5 varieties) | E330 = citric acid |
| **E-number content** | E100, E150a, E160 E160b, E160c, E162 E262, E270, E296, E307, E327, **E330**, E339, E341, E471, E508, E551, E552 E621, E627, E631, E635 | E102, E110, E150, E160c, E162, E223, E322, **E330**, E471, E503, E500 | E102, E110, E129, E141, E160a, E160e, E202,E415, E211, **E330**, E331, E410, E412, E440, E461, E466 | |

The frequently used content of food additives in crisp products are: capsicum extract (E160c), silicon dioxide (E551) and monosodium glutamate (MSG) (E621), in biscuit products are: soy lecithin (E322), sodium (bi)carbonate (E500) and in fruit juice products are: potassium sorbate (E202), sodium benzoate (E211) and carboxymethylcellulose (E466). It was noticed that the frequency of use (%) of these food additive is less in crisps and fruit juices when compared with biscuits. This is because of using more varieties of food additive types in crisps and fruit juices. The classification and purpose of use of these additives are presented in Table 2.

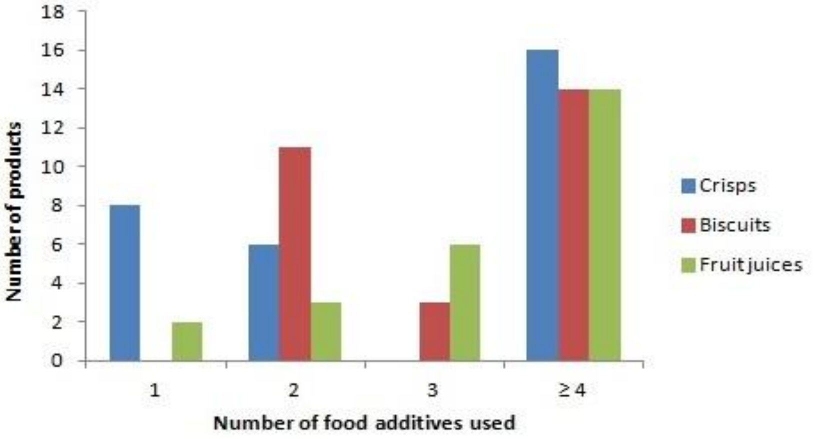
**Table 2.** *Food Additives (E-Numbers) Content in the Selected Crisps, Biscuits and Fruit Juices Recorded by Frequency (%), Full Name, Class, Sub-Class and Use*

| | Frequency (%) | Full name | Class | Sub-class | Purpose of use |
|---|---|---|---|---|---|
| **Crisps (n = 30)** | | | | | |
| E160c* | 18 (60) | Capsicum extract (red) | Dyes and Coloring | Color | Food color as well as flavoring agent |
| E330* | 12 (40) | Citric acid | Antioxidant & acidity Regulators | Citrates & tartrates | Acidity regulator |
| E551* | 12 (40) | Silicon dioxide | pH regulators & anti-caking agents | Silicates | Used as anti-caking agent + anti-foaming agent |
| E621* | 13 (43.3) | Monosodium glutamate | Taste enhancers | Glutamates and guanylates | Taste Enhancer |
| **Biscuits (n = 28)** | | | | | |
| E322* | 23 (82.1) | Soy lecithin | Emulsifiers, stabilizers & thickeners | Lactates | Emulsifier and stabilizer of water-oil/fat mixtures |
| E330* | 16 (57.1) | Citric acid | Antioxidant & acidity Regulators | Citrates & tartrates | Acidity regulator as well as aroma compound |
| E500* | 24 (85.7) | Sodium (bi)carbo-nate | pH regulators & anti-caking agents | Miniral acids and bases | Acidity regulators, alkali, and rising agent |
| **Fruit juices (n = 25)** | | | | | |
| E202* | 12 (46) | Potassium Sorbate | Preservatives | Sorbates | Preservative |
| E211* | 10 (40) | Sodium benzoate | Preservatives | Benzoates | Preservative |
| E330* | 16 (64) | Citric acid | Antioxidant & acidity Regulators | Citrates & tartrates | Acidity regulator |
| E466* | 13 (52) | Carboxy-methyl-cellulose | Thickeners, stabilizers & emulsifiers | Cellulose compounds | Emulsifier |

*Note*: * The ADI values for these food additives are "not specified" and are found acceptable for specified use by Scientific Committee on Food of the European Commission (Commission of the European Communities 2001).

Upon further analysis of the food's ingredient label, only 10 products (12%) of selected crisps, biscuit and fruit juices contain only a single food additive (Figure 1). Chi square analysis of the number of food additives used in crisps, biscuits and fruit juices showed to be significant ($p$=0.002) which indicates that there is a relationship between the type of food and number of food additives used.

**Figure 1.** *Number of Food Additives (E-Numbers) Used in Selected Crisps, Biscuits and Fruit Juices*




*Pilot Survey on Public Perception of E-Numbers*

Analysis of the data collected from 250 participants revealed that 57% of the participants are male and 43% female, among them 64% are Omanis. Regarding age, majority of participants (71%) can be classified as young parents (56% are of the age range from 25-35 years old and 15% are of the age range from 36-50 years old). Almost half of the participants (53%) have a graduate (44%) and postgraduate (9%) level of education.

Participants response to the questions related to knowledge showed a mixed response to the questions "how would you rank your knowledge about the E-numbers which are used in foods?" by which 36% answered very good, 29% answered poor and 35% answered I don't know anything about it and "Effect of E-numbers on health" by which 21% answered may cause harm, 17% answered good for us, 24% answered depends on use and 38% answered I have no idea. Participants' response to some other questions was: A product having more than one E-number could cause harm to health in large quantities: Yes (51%), No (14%), I don't know (35%) and E-numbers make food taste delicious and look attractive: Yes (45%), No (30.0%), I don't know (25%). When analysing the data by nationality (Omani vs expatriates) it was found that expatriates seemed to be better informed as compared to Omanis. Meawhile, Omanis having a better attitude than expatriates with respect to E-numbers as shown in Table 3.

**Table 3.** *Knowledge and Attitude Towards E-Numbers by Nationality; Omanis and Expatriates*

| Knowledge | | Omani | | Expatriate | | p-value |
|---|---|---|---|---|---|---|
| | | Count | Percentage (%) | Count | Percentage (%) | |
| Rank your knowledge of E-numbers used in foods | Very good | 40 | 24.8 | 51 | 57.3 | < 0.05 |
| | Poor | 50 | 31.1 | 22 | 24.7 | |
| | I don't know anything | 71 | 44.1 | 16 | 18.0 | < 0.05 |
| Effect of E-numbers on health | May cause harm | 14 | 8.7 | 40 | 44.9 | < 0.05 |
| | Good for us | 26 | 16.1 | 18 | 20.2 | |
| | Depends on use | 44 | 27.3 | 15 | 16.9 | |
| | I have no idea | 77 | 47.8 | 16 | 18.0 | < 0.05 |
| A product having more than one E-number could cause harm to health in large quantities | Yes | 73 | 45.6 | 54 | 60.7 | < 0.05 |
| | No | 20 | 12.5 | 15 | 16.9 | |
| | I don't know | 67 | 41.9 | 20 | 22.5 | < 0.05 |
| **Attitude** | | | | | | |
| It is important to know what a food product contains | Yes | 157 | 97.5 | 79 | 88.8 | < 0.05 |
| | No | 4 | 2.5 | 10 | 11.2 | |
| It is not important to check on the packaging whether a food product contains E-numbers | Yes | 46 | 28.6 | 36 | 40.9 | |
| | No | 115 | 71.4 | 52 | 59.1 | |
| I pay attention during shopping that the food products I buy contain as much natural ingredients as possible | Yes | 128 | 79.5 | 60 | 67.4 | |
| | No | 33 | 20.5 | 29 | 32.6 | |

## Discussion

In the past century, we have witnessed a marked increase in the number of food additives being added to food products. Today, more than 3,000 substances are approved for use as food additives by national and international food regulatory bodies (Wilson and Bahna 2005). Generally speaking, the majority of food additives do not provide any nutritional benefits to the consumer, therefore there are two factors that strongly influence the use of a particular food additive, which are safety and technological needs. Any food manufacturer has a priority to provide a wide range of safe and attractive products at affordable prices all year round in order to meet consumer requirements for quality, convenience and variety. It would be impossible to do this without the use of food additives. Different types of additives are used for different purposes and they are grouped according to their primary function (Haen 2014, Saltmarsh 2013).

*The Type, Nature and Safety of Food Additives in Selected Products*

Upon analysis of the results and as shown in Table 2, certain type of food additives are used more in crisps, biscuits or fruit juices than other types due to the fact that these are essential in their production. For example, food flavoring and taste enhancers are utilized more in the production of crisps than in case of biscuits which require emulsifiers and fruit juices which require preservatives in their production.

Some of the food additives are natural substances and others are synthetic, but the distinction is blurred when naturally occurring substances are synthesized in the laboratory, and might thereby acquire unwelcomed contamination. Synthetic additives used in crisps, biscuits and fruit juices are: silicon dioxide (in crisps), sodium (bi)carbonate (in biscuits), potassium sorbate and sodium benzoate (in fruit juices). Replacing synthetic food additives with more natural ingredients which can perform similar technological function is in a growing demand by consumers due to safety concerns. A number of ingredients such as emulsifiers; soya proteins and lecithin, antioxidants; grape seeds, chestnut, olive leave extracts, colors; lycopen, anthocyanin, chlorophyll, and preservatives; cinnamic acid, carvacol, can be used as substituents for the synthetic food additives which gives the food product a "clean label" status (Saltmarsh 2013).

There are no intake limitations reported with these food additives except for potassium sorbate which has an ADI value of 25mg/Kg and for sodium benzoate which has an ADI value of 5mg/kg (Commission of the European Communities 2001). The ADI value is the amount of substance that can be safely consumed, daily, throughout a lifetime. In establishing the ADI a safety factor is always built in, usually 100-fold, to ensure that intake of any additive is unlikely to exceed an amount that is anywhere near toxicological harmful especially with consumers who are consuming too much of products containing a particular additive.

*Health Risks Associated with Consumption of Food Additives Used*

Several studies have investigated the prevalence of adverse reactions to food additives (Saltmarsh 2013, Young 1997). According to Millstone and Lang (2008), doubts have been raised about approximately 200 food additives, which for certain consumers have been claimed to cause intolerance or allergic reactions, or to significantly increase risks of serious long term harms. It has been estimated that the true prevalence of intolerance to food additives is about 2% in adults and up to 20% in children, and for food additives from 0.01 to

0.23%. MSG and citric acid are among food additives which are used frequently in the selected products and are associated with reported adverse reactions. MSG, which is used in crisps as a test enhancer, is widely blamed for an intolerance reaction that became known as "Chinese Restaurant Syndrome". This syndrome was first described by Kwok in 1968 and later by Geha et al. (2000) as a triad of symptoms that consisted of numbness starting in the back of the neck with radiation to the arms and back. In addition, MSG has been also suspected to induce a neurotoxic effect on the nervous system (Quines et al. 2014), trigger asthma (Yoneda et al. 2011), and liver injury (Nakanishi et al. 2008).

Citric acid is used in all selected crisps, biscuits and fruit juices as an antioxidant and acidity regulator. The wide use of citric acid in food products is mainly related to its very low toxicity reported *in vivo* experiments (Saltmarsh 2013). However, citric acid can be associated with atopic syndrome in children, especially atopic dermatitis (Fuglsang et al. 1994). Another hypersensitivity reaction was reported by Pradalier and Di Palma (1984) and presented in the form of chronic buccal aphthous ulcers due to the excessive consumption of foods and beverages contain citric acid.

Other food additives used in the selected products (Table 1) such as Tartrazine (E102), Sunset yellow (E110), Allura red (E129) and Sodium benzoate (E211) are suggested to be causing hyperactivity and lack of attention, also known as Attention Deficit Hyperactivity Disorder, in children upon excessive consumption. Feingold in 1973 was the first to report the effect of food additives on children’s behavior and followed by further investigations by other researchers (Stevens et al. 2014, Arnold et al. 2013, Feingold 1973).

*Excessive Food Additives Content*

It was noticed that there is an excessive food additives content in the selected crisps, biscuits and fruit juices represented by the use of more than one food additive per product. Figure 1 shows that 63.9% (53 products) of these products contain more than 3 types of food additives. A strong relationship is there between the type of food and number of food additives used; as the manufacturing of biscuits require the use of two or more food additives when compared to that in crisps and fruit juices to achieve proper desirable product outcome.

These selected products are commonly consumed by children and adults alike and usually consumed randomly, in combination and in large quantities throughout the day (Kant and Graubard 2015, ACS 2013, Ogden et al. 2011). This type of eating behavior and the repetitive exposure to these additives could load the body with these additives and may lead to adverse reactions to appear. Further, cross reactions and combination effect of the consumed additives is almost lacking in the literature which could also put the consumer into an unknown health risk if these products were frequently consumed in large quantities.

*Public Perception of E-Numbers*

The results of the survey showed that participants do not have sufficient knowledge about E-numbers and their impact on health which is clear in their mixed response towards some questions. This indicates the lack of risk and benefit perception towards E-numbers which is in agreement with the literature (Dickson-Spillmann et al. 2011, Shim et al. 2011). The results also showed that food habits/culture by Omanis seems to differ than that of the expatriates. Omanis tend to eat more natural/homemade type of food, therefore have more cautious approach when dealing with processed and packed foods by reading the food ingredient label. Expatriates seem to care less about reading the food ingredient label although they are more informed than Omanis regarding E-numbers.

Food additives are generally safe if consumed reasonably by adhering to the ADI. However due to the fact that the ADI values are mainly set for adults, attention must be given to young children who consume snack foods and beverages in large quantities per day if they were unsupervised. Among the additives which are still being in use by the food industry till date is MSG which is reported, as discussed earlier, to have adverse reactions upon large consumption. The public survey outcome suggests the lack of risk and benefit perception towards E-numbers in general public especially in young parents which could lead to an inappropriate guidance of their children for better healthy food choices. Therefore guidance in respect to this issue is essential which will have a long term impact on family health for generations to come and requires more research.

## Conclusion

The use of food additives and proper risk and benefit perception towards these additives can be utilized by the consumer for better food choices. However, excessive food additives content could expose the consumer to a possible unknown risk of cross reactions especially with snack foods and beverages which are consumed randomly and in combinations. Research is lacking regarding cross reactions between food additives used in food products in general and further investigation is required in this regard.

## Study Limitations

Since this research work is an undergraduate research project, time has been considered as a limitation to: 1) carry out quantitative analytical study to investigate the amount of additives in the selected products and if their use is within the allowed limits. Therefore, we recommend further research to look into this issue; 2) extend the questionnaire, which is used in the survey, to include questions related to practice such as eating preferences and frequency of food consumption. Hence, the focus was only on the knowledge and attitude of consumers.

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