Journal of Food and Nutrition Sciences
2026, Vol. 14, No. 6, pp. 408–418
https://doi.org/10.11648/j.jfns.20261406.11

Research Article

Assessment of Processed Foods Consumption Habits of Preschool Children and Their Exposure to Food Additives in Burkina Faso's Main Urban Cities

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Abstracts

This study aimed to evaluate processed foods consumption habits of preschool children and their associated chemical additive risks in Ouagadougou and Bobo-Dioulasso, two main urban cities of Burkina Faso. Therefore, the survey involved sixty volunters preschools on processed foods used in their canteen menu, and 1120 parents concerning the use of processed foods for their children at home, and their knowledge on food additives and their dangers. Usual processed foods consumed by preschools children were then collected in school' markets, and their contents of food chemical additives were firstly listed. and their danger evaluated based on standards and previous works. A total of 1120 parents' including 71.2% women and 28.8% men were involved in the study. Preschool students were 53.39% girls and 46.61% boys, from two- to six-year-old. Main processed foods were crips, sweets, chocolates, dairy products, cereals, biscuits, and juices. Parents (91.70%) were not aware about food additive danger for children's health. Processed foods are more consumed at home than in schools. On overage, processed foods are consumed on regular based, at least few times a week. Sixty-four different food additives were listed among which eighteen are listed red additives, including Brilliant Blue FCF (E133, Ponceau 4R (E124), Azorubine, carmoisine (E122), Allura Red AC (E129), Orange yellow S (E110), Tartrazine yellow (E102) which are prohibited in several countries because of health risk evidences. Some listed food additives have a high danger level on children's health taking into account the consumption frequency. It is therefore necessary to reinforce national regulatory measures.

Keywords

Food Additives, Processed Foods, Preschool, Health Danger, Burkina Faso

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Received: 23 October 2026; **Accepted:** 3 November 2026; **Published:** 16 November 2026

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1. Introduction

High processed foods are alternatives to homemade foods for several reasons. They help preserve foods, improve flavor and taste, and are convenient (ready-to-eat). These ready-to-eat foods reduce both work time and food budget in families. As a result, processed foods have become embedded in the dietary habits of some communities in both developed and developing countries. Foods additives are among basic elements of processed food [1]. Nowadays, there are twenty-three categories of food additives, from food colorants to flavor enhancers [2, 3]. And, their misuse or overuse can lead to health risks for consumers [4-6]. Everyone is concerned about the health risk associated with food additives, particularly children [7].

Early childhood (birth–4 $^{1/2}$ years) is the age when children begin to explore food. They display an highly adaptive behaviors in relation to food, enjoying a variety of foods [7, 8]. During their early years, children acquire experience in relation to food knowledge. They identify what their parents eat, know what they themselves or their loved ones like or dislike. From the age of 5 years, they are able to reason about why foods are acceptable or unacceptable, citing notions of cleanliness/contamination, danger, consistency with habits, knowledge of adult judgments [9]. Early childhood is therefore both a delicate and decisive period in the development of eating habits. Eating behaviors that are developed during childhood are crucial, as they are likely to persist in adulthood. Furthermore, in the medium term, food quality influences children's cognitive and behavioral development [10]. Special care should be taken with the diets in early childhood because of their age group and the future impact this could have. Burkina Faso has not yet set regulatory framework for food additives. However, the regulation for some local food products indicate maximum limits for certain food additives. Unfortunately, children are among the vulnerable groups of unfair effect of food additives, alongside with pregnant women, and those with pre-existing health problems. The cumulative food additives risk (Hazard index) was highest among children (1.8) in Ukraine than among adults population subgroups [11]. Some studies [12] point out the misuse of food additives in artisanal and semi-artisanal processing units. But people exposure in general and vulnerable groups exposure to food additives that reveal remain unknown. This study aims to assess preschool children's exposure to fodd additives in their main food environnements, namely school and hom.

2. Materials and Methods

2.1. Study Design and Location

The investigation is a prospective, analytical, and cross-sectional study. Data were collected in sixty (60) kindergarden schools located in Ouagadougou and Bobo-Dioulasso, the two main urban cities of Burkina Faso. [13] of population repartition have been used to categorize three schools locations in both cities: poor neighborhoods, rich neighborhoods and middle neighborhoods.

2.2. Study Population and Simpling

Three populations were considered in this study: preschool principals, preschool children's patents, and processed foods sold in school markets. Preschools' principals were surveyed on school canteens' menus and processed foods used. Parents provided information on their socio-professional status and knowledge about food additives, their children's age, school level and food habits. The frequency of main processed food consumption was also recorded. Processed foods commonly consumed by children were collected in school markets, and the list of food additives in each food item has been compiled.

Three samples are considered: kindergarden schools, preschools parents and processed foods. Sixty kindergarden schools were sampled, thirty from each city, Ouagadougou and Bobo Dioulasso. As parents's number was unknown before, the minimum sample size in each city was calculated using the following formula:.

$$n \geq \frac{Z^2 * P(1-P)}{d^2}$$

$$n \geq (Z*P(1-P))/(d)$$

n= minimum sample size

z= confidence level according to the reduced centered distribution (for a 95% confidence level, z = 1.96, for a 99% confidence level, z = 2.575. And, for a 99% confidence level (z=2.575), n=664.

p= estimated proportion of the population that exhibits the characteristic (when unknown, p = 0.5 is used, which corresponds to the worst case, i.e., the greatest dispersion)

d= margin of error

A total of 1126 parents of early childhood from sixty schools of the two cities were surveyed. All kind of processed food in preschools markets including sweets, juices, dairy products, chips, chocolate were collected to list food additives and assess their health issue for pupils.

2.3. Data Collection

2.3.1. Data Collection with School' Principles

The data were collected in schools which have canteens. The aim was to collect information on processed foods (candy, juice, crisps, dairy products, biscuits, chocolate, etc.) in the canteen and also unprocessed foods used such as fruit.

2.3.2. Data Collection with Parents

Parents were surveyed for their early childhood pupils. Data collected with parents included their socio-professional's, their children age, school level, food habits mainly processed foods (candy, juice, chips, dairy products, cookies, chocolate) consumption frequency. Parents' knowledge about food additives and their children food' restrictions were also recorded.

2.4. Food Additives Recording and Health Risk Assessment

Processed foods sold in schools markets were collected for food additives assessment. Food additives names, properties, and E code is completed, based on Codex STAN 192 (1995), Barbier du Vimont (2008) and Auvinet et al., (2024). Aacceptable daily intake (ADI) of each additive is from [14-16] Barbier du Vimont (2008), European Food Safety Authority [16] and the US Food and drugs administration standards were used to appreciate the food additives danger and health risks.

2.5. Data Collection Stools

An electronic questionnaire designed on KoboTolbox platform was used for data collection with preschools principals and pupils'parents. The questionnaires were then deployed on smartphones, which were used for data collection. An XlsForm v_ 2019 was used to record food additives in processed foods items collected in preschools marks. All vendors of foods at the preschool markets were assessed for food additives in their products.

2.6. Data Analysis

Data were imported into SPSS version 25 software for basic analysis. Microsoft Excel 2019 has been used for graphs design.

2.7. Ethical Consideration

An authorization was first obtained from the two Regional Directorate of the Ministry of Basic Literacy and National Languages Promotion. A request for data collection authorization was then submitted to each preschool school principal. Then, consenting schools that approved the request are those included in the study. In each school, only parents who were volunteers and orally consent that participate in the study, and were considered and interviewed. Confidentiality and anonymity of parents and schools were ensured.

3. Results

1) Preschools's canteen practices and processed foods

Preschools enrolled in this study (60) were from poor neighborhoods (24), middle-class neighborhoods (23) and wealthy neighborhoods (13) from Ouagadougou and Bobo-Dioulasso, according to categorization of population used by [13]. Almost all preschool (90.62%) provide snacks for their pupils (Table 1). In schools providing snacks, the canteen menu was proposed by three categories of persons: the principal (60% of cases), the school's founder (20%), the parents' association (13.34%), and a health professional or dietitian (6.66%). The variation of the canteen menu depended on the school self-designed policy. Hence, 40% had an invariable menu all the year, 25% have a monthly based's menu. Others have respectively quartertly (11.67%), weekly (11.67%), and flexible menu (11.67%) depending on raw material availability. The majority of schools (68.33%) used processed foods in their canteens. Some schools reported food allergy cases (8.33%).

Table 1. *Surveyed preschools' characteristics and canteen practices.*

	Ouagadougou		Bobo Dioulasso		Both cities	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Schools' location						
Poor neighbourhood	11	36.66	13	43.33	24	40.98
Middle-class neighbourhood	10	33.34	13	43.33	23	37.70
Wealthy neighbourhood	9	30.00	4	13.34	13	21.32
Total	30	100	30	100	60	100
Person preparing the canteen menu						
Principal	19	63.33	17	58.62	36	60
Founder	6	20.00	5	17.24	12	20
Parents' Association	3	10.00	5	17.24	8	13.34

	Ouagadougou		Bobo Dioulasso		Both cities	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Nutritionist/Health staff	2	6.67	3	6.90	4	6.66
Total	30	100	30	100	60	100
Frequency of canteen menu preparation						
Invariable all year round	6	19.36	18	62.07	24	40
Quarterly	6	19.36	1	3.46	7	11.66
Monthly	11	35.48	4	13.79	15	25
Weekly	4	12.90	3	10.34	7	11.67
Flexible, depending on availability	4	12.90	3	10.34	7	11.67
Total	31	100	29	100	60	100
Use of processed foods in the canteen						
Yes	23	76.66	18	60.00	41	68.33
No	07	23.34	12	40.00	19	31.67
Total	30	100	30	100	60	100
Food allergies reported by parents						
Yes	0	0.00	5	83.33	5	8.33
No	30	100	25	16.67	55	91.67
Total	30	100	30	100	60	100

2) Children and parents' profiles and food additives knowledge

A total of 1120 parents, 513 in Ouagadougou and 607 in Bobo Dioulasso were surveyed, including 71.2% women (797) and 28.8% men (323). Table 2 presents parents' characteristics and knowledge about food additives. About 40.26% of the parents attended high school, 39.73% attended secondary school and 8.8% primary school. Parents who did not attend school represented only 11.25% of the respondents. About a third of parents (29.2%) indicated they have food restrictions for their children, and prohibited foods mentioned by parents included candy, chewing gum, chips, chocolate, soft drinks. The main reasons for this food restrictions are: tooth decay prevention, abdominal pain, addiction to sweet tastes, food allergies. Food additives are not really known among parents. Only 6.4% of parents included in the study have knowledge about food additives and 6.1% of them were aware about food additives' dangers.

Table 2. *Parents social characteristics and food additives knowledge.*

	Ouagadougou		Bobo Dioulasso		Both cities	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Parents' sex						
Female	393	76.60	403	66.60	797	71.2
Male	120	23.40	204	33.40	323	28.8
Total	513	100	607	100	1120	100
Instruction level						
High school	214	41.70	237	39.04	451	40.26
Secondary school	200	39.00	245	40.37	445	39.73

	Ouagadougou		Bobo Dioulasso		Both cities	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Primary school	33	6.40	65	10.71	98	8.8
Not attending school	66	12.70	60	9.88	126	11.25
Total	513	100	607	1120	1120	100
Food restriction and prohibition practices						
Yes	363	70.76	405	66.72	768	68.57
No	150	29.24	202	33.28	352	31.43
Total	513	100	607	100	1120	100
Knowledge of food additives						
Yes	480	93.60	402	66.20	93	8.30
No	33	6.40	205	33.80	1027	91.70
Total	513	100	607	100	1120	100
Knowledge about food additives danger						
Yes	482	93.90	547	90.10	1029	91.88
No	31	6.10	60	9.90	91	8.22
Total	513	100	607	100	1120	100

Pupils's profile and their processed food consumption is shown in Table 3. Girls (53.39%) are more than boys (46.61%). Most of the children were between 3 and 5 year-old (18-42%) and were attending equally first, second, and third year of preschool. According to their preschool grade level, the representative grade is second year class (39.73%), followed by third year class (31.07%). First year class pupils are the least represented (29.20%). Almost all parents (97%) state that their children consume processed foods at home.

Table 3. *Children profiles and processed foods consumption.*

	Ouagadougou		Bobo Dioulasso		Both cities	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Children sex						
Female	280	52.20	404	66.60	598	53.39
Male	230	44.80	203	33.40	522	46.61
Total	513	100	607	100	1120	100
Children age						
Two-year-old	28	5.5	9	1.50	37	3.30
Three-year-old	187	36.5	204	33.60	391	34.91
Four-year-old	187	36.5	288	47.40	475	42.41
Five-year-old	99	19.3	102	16.80	202	18.04
Six-year-old	12	2.3	4	0.50	15	1.34
Total	513	100	607	100	1120	100
Preschool level						

	Ouagadougou		Bobo Dioulasso		Both cities	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
First year	216	42.1	215	35.40	327	29.20
Second year	185	36.1	260	42.80	445	39.73
Third year	112	21.8	132	21.7	348	31.07
Total	513	100	607	607	1120	100
Processed food consumption						
Yes	494	96.30	592	97.50	1086	97.00
No	19	3.70	15	2.50	34	03.00
Total	513	100	607	100	1120	100

3) Processed food consumption frequency in preschool canteen and at homes

The frequencies of processed food and fruits consumption by preschool children in schools' canteens are presented in Figure 1. Crips, chocolates and sweets are the least consumed processed food in canteen, while cereals, juices and dairy products are more included, few times a week. More occasionally processed food in canteen are biscuits, sweets and juices. On a daily based, processed foods accounted are juices, dairy products, and cereals. Fruits are served respectively only few times a week, occasionally, once a week. Some schools do not provide fruits in their canteen menu.

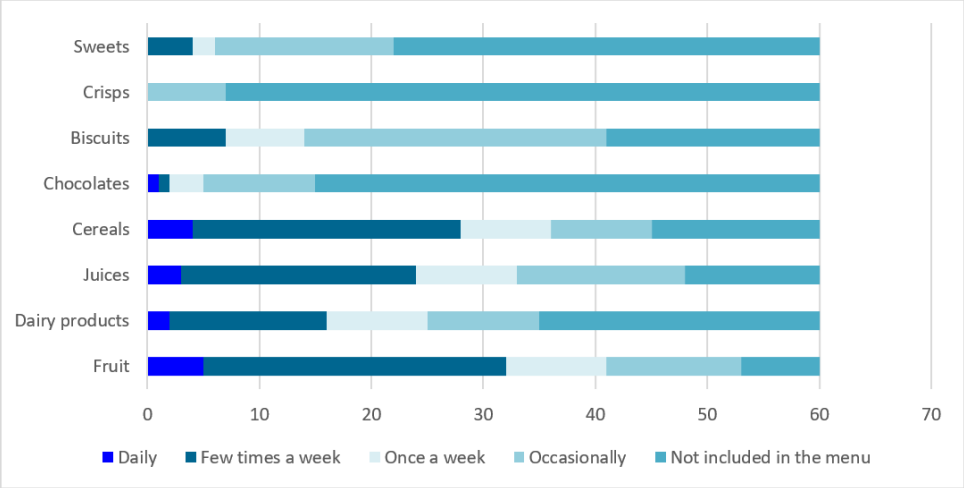


Figure 1. *Processed foods frequency in preschool canteens.*

Processed food consumption at children's homes was presented in Figure 2. Generally, processed foods were consumed respectively from time to time (35.89%), few times a week (37.5%), once a day (12.32%), several times a day (10%) and once a week (1.79%). About 2.5% of parents don't include processed foods for their children's diets. When taking to account several times a day frequency, the main processed foods are juices (10.71%), cereals products (10%), dairy products (9.38%), and crisps (9.29%). Crips (10.98%), sweets (9.20%) and chocolates (8.57%) are the most prohibited processed foods in children food habits.

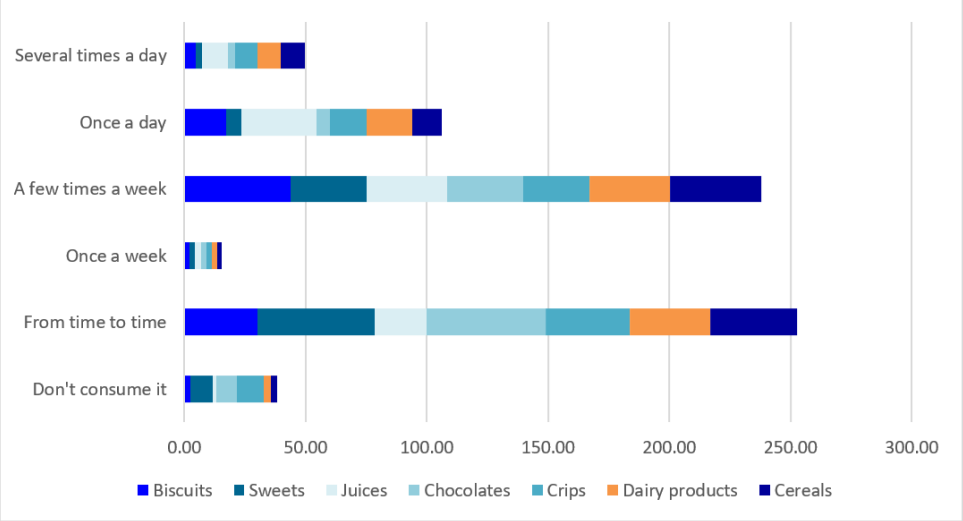


Figure 2. *Processed foods consumption's frequency at children's homes.*

4) Foods additives in children's processed foods

A total of sixty-four (64) different foods additives have been listed from common processed foods consumed by preschool pupils, both in schools and at homes. Figure 3 shows the diversity of these 64 food additives according to categories recorded. The more representatives food additives were respectively antioxidants, texturing agents, colorants, acidity regulators, and anti-caking agents. The less represented were respectively flavor enhancers, sweeteners, and preservatives.

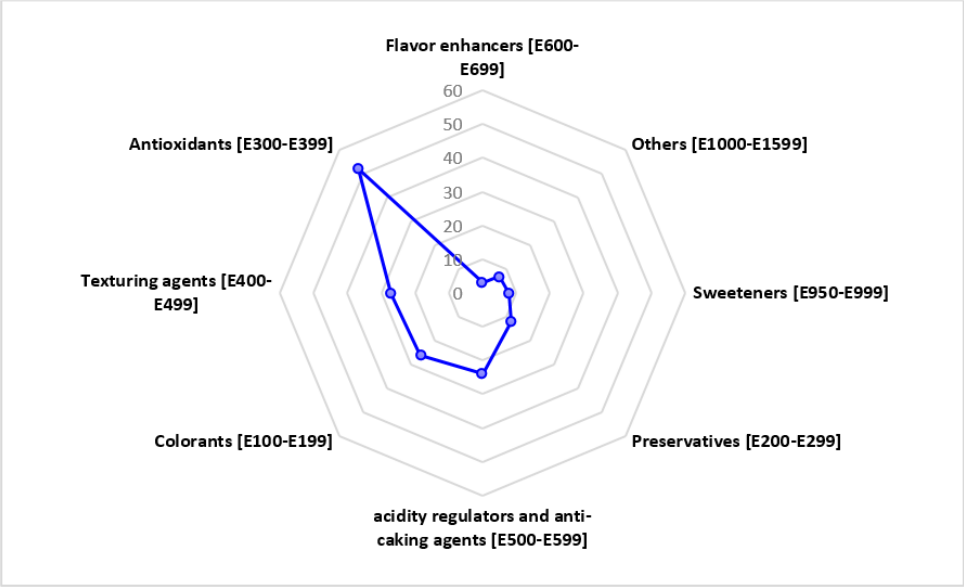


Figure 3. *Categories of the 64 food additives in children processed foods.*

Additives of different danger level were listed in processed foods consumed by preschool pupils. It includes additives classified as green additives (acceptable), orange additives (not recommended), red additives (to be avoided), gray additives (unclassified additives). Figure 4 presents the distribution of listed additives in processed foods according to their level of danger.

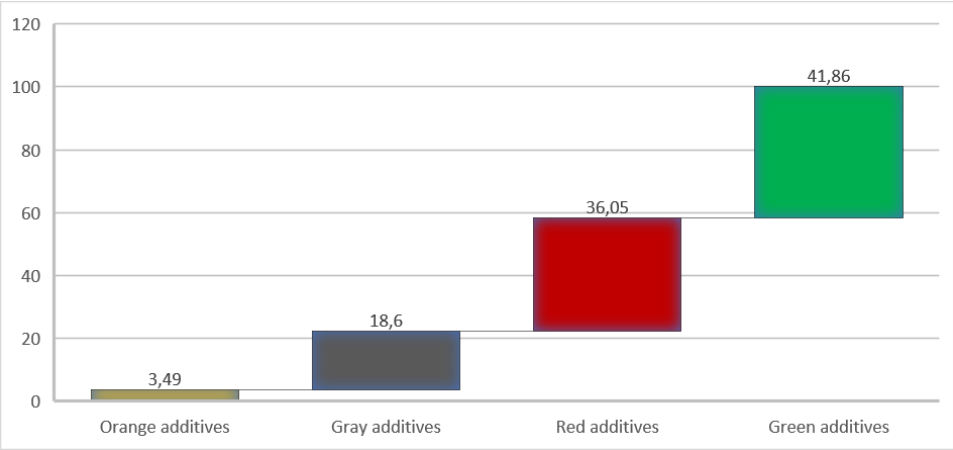


Figure 4. *Distribution of listed food additives according to their level of danger.*

Red additives were mainly found in crips, chocolates, juices, biscuits and sweets while green additives were found in dairy products, sweets, chocolates and juices. Gray additives are mainly found in biscuits, crips, juices and sweets. Figure 5 presents the proportion of additives according to the danger level.

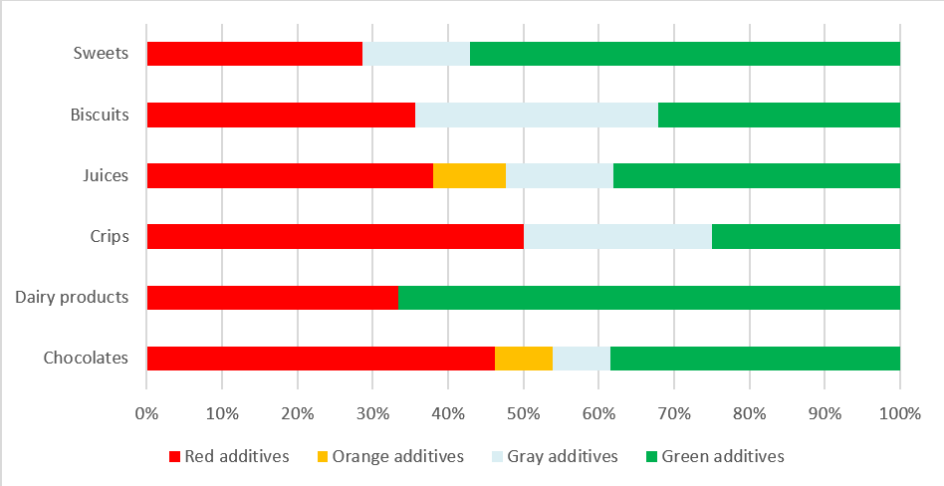


Figure 5. *Distribution of food additives by risk level in main processed foods.*

4. Discussion

This survey on preschools revealed a common consumption of processed foods by early children both at home and in schools. Frequencies showed that processed foods are part of their food habit. They are then exposed to food additives with probable health risks.

Processed foods have become part of children's eating habits both in schools and at home. These processed foods are more regular at home (97.5%) than in school canteens (68.7%). This difference may be related to the number of meals served per day in schools and families. Processed foods are daily consumed in families. The main processed foods are found in school markets whether in wealthy or poor neighborhoods. Parents instruction level doesn't have an effect on processed foods consumption in families. [17] also demonstrated and increase in ultro-processed foods across all income quintiles in Brazil. Previous studies demonstrated and established processed foods habits in families as a result of modern food habits [18, 19]. The main frequencies are few times a week (37.5%) and from time to time (35.89%) at home. Their consumption is also well established in many schools. Health professionals and dietitians advices may have contributed to reduce processed foods used in some schools. But canteens in surveyed schools still not meet international requirements concerning food balance in school canteens [10]. Many reasons could stand for these processed foods exposure in early childhood. Among them, the lack of knowledge of parents about food additives and their danger. Previous works point out urbanization, technological advancements, and shifting

lifestyles as main reasons of processed foods increase in families [18]. Processed foods introduction at this age stage is a risk for children food diversity appreciation, their cognitive and behavioral development and their weight status and general health [8-11, 20].

The exposure to processed foods leads to an exposure to food additives. Sixty-four (64) different foods additives have been listed in processed foods reported to be used at home or in schools. Among them, red additives (36.05%), the second important group (Figure 4) and the one of interest based on their health risk associated is important. They are found in diverse food category regularly consumed by early childhood students (Figure 5). Eighteen red food additives of different risk levels have been listed in these processed foods (Table 4). Preschool children are then exposed to several health risks according to recorded food additives in processed food that they consume. Eighteen (18) foods additives classified as red additives have been recorded. Table 4 shows these additives and their health issue.

Table 4. *Health risks of red additives in listed processed food for preschool children.*

Additives (Code)	Category	ADI	Main health issues
Tartrazine yellow (E102)	Colorant	7.5	Carcinogenic and mutagenic, allergies, hyperactivity (in children)
Orange yellow S (E110)		2.5	Allergies, asthma, agitation, stomach aches, vomiting
Allura Red AC (E129)		7	Probable carcinogens, allergy and hyperactivity (in children)
Azorubine, carmoisine (E122)		4	Allergies, asthma, edema, insomnia, could be carcinogenic
Ponceau 4R (E124)		4	Risk of insomnia, excitement, would be carcinogenic
Erythosine (E127)		0.1	Allergies, asthma, risk of insomnia, excitation, risk of cancer
Brilliant Blue FCF (E133)		10	Risks of allergies, insomnia and cancer
Ammonia caramel (E150c)		200	-
Sulphite ammonium caramel (E150d)		200	-
Sodium benzoate (E211)	Anti-oxygen	5	High risk of allergies, excitation, eye irritation, insomnia, growth disturbance. May have links with leukemia
Propyl gallate (E310)		0.5	Allergies, hyperactivity, insomnia, liver and kidney problems, lymphomas
Tertiary butylhydroquinone (E319)		0,7	Allergies, weakened immune defense
Sodium diphosphate (E450)	Texturizing agent	70	Allergies, cardiovascular disorders, digestive disorders and hyperactivity in children (Excessive consumption).
Sodium pyrophosphate (E450i)		70	Allergies, cardiovascular risks, digestive disorders, hyperactivity (children)
Mono and diglycerides of fatty acids (E471)		ns	Growth blockage, enlargement of the liver and kidneys, poor absorption of essential fatty acids, uterine disorders, reduction in the size of the testicles
Mono- and diacetyl tartaric acid esters of mono- and diglycerides of fatty acids (E472e)		25	Growth blockage, enlargement of the liver and kidneys, poor absorption of essential fatty acids, uterine disorders, reduction in the size of the testicles
Sucrose esters of fatty acids (E473)		25	Suspected of being carcinogenic
Aspartame (E951)	Sweetener	40	Possibly carcinogenic to humans (IARC), articularly dangerous for people suffering from phenylketonemia

Among theme, some are prohibited in several countries because of health risk evidences, including brilliant Blue FCF (E133), ponceau 4R (E124), azorubine, carmoisine (E122), allura Red AC (E129), orange yellow S (E110) and tartrazine yellow (E102) [21]. Propyl gallate (E310) is forbidden in children's foods in some countries [21]. Others additives (E319 and E211) are autorized under specific conditions or regulations. Aspartame (E951) which was forbidden in the European's union (EU) and re-evaluated is still contested by the International agency for research on cancer (IARC), the League against cancer, Foodwatch. New evidences call for it re-evaluation [4]. The effects of these additives on the brain, liver, kidney, lungs, urinary bladder, and thyroid gland have been documented [6]. Among health risks for children, their are carcinogenic and mutagenic, allergies, hyperactivity, asthma, agitation, stomach aches, vomiting, edema, insomnia, growth disturbance [5, 7, 22, 23]. Food additives impact on gut microbia have been demonstrate [20, 24-26].

The consumption of many additives at the time will have associated effects. In fact, some processed foods content many additives. The survey put out many processed foods consumption in a daily basis by preschools pupils. There is also a misuse of food additives in some industries, leading to rather high level or unlisted additives [12]. In addition to food additives, processed foods have high salt, sugar and lipids content which are of additional health risk [27-29]. Childreen are then exposed to food additives danger with a cumulative effect and other danger tributed to ultra-foods ingredients.

This study doesn't either quantify food additives in processed food or measured daily intake of processed food consumed to better appreciate the health risk. But, all these health issues need to be resolved by good food habits for preschools pupils, avoiding undesirable compounds. At the national level, there is a need of legislation to guide industries and protect citizens'health, particularly children.

5. Conclusion

Processed foods integrated preschools pupils food habits both in schools and at homes despite of parents education level as an alternative to nowadays modern lifestyle. In both cities, processed foods are consumed sometime in a daily basis, many at a day with minor food restriction. These frequencies increase the health risk level. Several additives posing an health risk, red additives were well represented in processed foods consumed by preschools pupils. These additives have an associated health risk, not to be neglected. The potential' health concern issues due to several food additives, processed foods ingredients call for attention for both parents, schools principals or founder and national level stakeholders.

Abbreviations

ADI	Acceptable Daily Intake
EFSA	European Food Safety Authority
IARC	International Agency for Research on Cancer
US	Unated State

Author Contributions

Guira Flibert: Conceptualization, Data curation, Methodology, Resources, Visualization, Writing – original draft, Writing – review & editing

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Drabo Soungalo Moustapha: Data curation, Writing – review & editing

Compaore Wendenda Cyntia Vanessa: Data curation, Methodology, Resources, Visualization, Writing – review & editing

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Sawadogo-Lingani Hagretou: Conceptualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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