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SAFE SAVOR

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Abstract - Food allergies are a considerable public-health consideration everywhere, particularly for people depending on online-shopping for groceries. Mistakes in labeling, information that is not structured, and not mentioning all the ingredients in the products' listing are partial reasons that lead to consumers being accidentally exposed to allergens. This thesis is to present Safe Savor, a Chrome-Extension created to identify allergens, their derivatives, and cross-reactive ingredients via studying products' ingredients section in real time on electronic commerce sites like Walmart. The extension uses dictionaries based on JSON, the user's inputs, and matching based on regex to display a reasonable alert and protect the user from possible health issues due to allergens. This thesis defines the technical frame-work, procedure, information sources, and possible results of Safe Savor, making it a functional option among applications specializing in the accessibility of user-centric allergen-detection.

***Key Words*:** Browser Extensions, Web Scraping, Food Allergies, Regex Matching, Data Parsing, E-commerce Safety.

1. INTRODUCTION

The evolution of online-shopping sites such as Walmart, Blinkit, and Zepto has shifted the tendencies of consumers through providing superior comfort. However, this change is challenging for people with food-allergies, as they cannot personally examine ingredient-labels of their products anymore. Inconspicuous presence of allergen, like milk in a dissimilar product like a potato-chip packet, elevates the danger of being accidentally exposed to the allergen, an issue which online-shopping sites aggravate. Food-allergies affect a lot of people everywhere leading to lots of hospitalizations and people seeking immediate medical attention year-round, particularly kids. Because of this, there is an emergency requirement for enhanced allergen-detection in online-shopping sites. Walmart's popularity has made it an important focal point for improving consumer-safety, encouraging the construction of Safe Savor, a Chrome-extension created to look for allergens and signal to the user without an initiative on the user's part on Walmart's webpages displaying products in real time. Safe Savor helps allergic customers buy consciously and demonstrates the usage of technologies in addressing public-health considerations, leading to way secure and mindful online-shopping as electronic commerce keeps expanding.

2. Literature Survey

Fig-1: Literature Survey Table

Ref no	Title of the work, publication & year	Author	Summary of the work [Methodology]	Research gaps and motivation
1	**Food Allergy and Nutrition Tracker,** International journal of multidisciplinary research in science, engineering and technology, 2024	Prof. Shoyeb Pathan, Shantanu Jape, Tanay Deshpande, Vaibhav Aurange, Omkar Kharadkar	The application allows the user to record food items themself, identify allergens, and gain alert-signals on the basis of an all-encompassing food-database.	Though the application provides user-specific allergen-tracking, it depends entirely on manual-entry, that might result in users accidentally omitting informed or making mistakes.
2	**Spoon Guru: Catering for shoppers' evolving dietary needs, with Nutrition AI,** An article by the Google Cloud Services, 2023	Spoon Guru Corp., in collaboration with Google Cloud Services	A dietary and allergen-filtering application which works with retail partners to provide user-specific suggestions for products on the basis of user-preferences. It uses barcode-scanning and organized information bases to help people choose food products carefully.	Its utility is depends on retail partners and consolidated information, making it difficult to keep it accessible and private. Safe Savor resolves this by providing a resolution based on the browser and independent of platform, preserving the information of users in local areas.
3	**Food Allergies and AI: Creating Safe Dining Experiences for Guests,** A medium post on 2024	Manos Karagiannis	Artificial Intelligence is changing the dining-experience by enabling safe and personalized food-shopping for people with food-allergies. Safe Savor offers this novelty to online-shopping, providing realtime allergen-detection for safe purchasing.	In spite of the increased utilization of Artificial Intelligence in hospitality for safe-dining, available resources mainly address allergen-management in restaurants, and not customer resolutions for food-shopping on online-shopping sites.

The literature-survey looks into different methods for allergen-detection and control, signifying the growing requirement for technologically enabled innovations to help people identify allergens in food-products. Present ways span options from personal label-reading to modern mobile and web apps which use image-processing, barcode-scanning, and NLP (Natural Language Processing) to identify allergens [1] [2] [3]. Various theses emphasize the significance of real time alert signals and user-specific information bases regarding allergens to improve user-safety. In spite of advancement, problems exist in making sure that the application is

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accurate, comprehensive, and easy to use, encouraging the creation of a more interwoven and user-friendly application like Safe Savor, the goal of which, is providing automatic sensing of allergens via a browser-extension, enhancing availability and consumer-protection

3. Objectives

An important aim of this undertaking is strengthening allergen-safety through developing a support-system which helps people avoid being accidentally exposed to allergens during the navigation through online-shopping sites. Owing to the changing pattern in food-shopping leaning more towards online-shopping, the undertaking improves digital-convenience to fill in for the lack of personal product-inspection, letting the user gain indispensable awareness regarding ingredient in real time. The goal is eliminating the ineffectiveness and danger due to the lack of personal allergen-scans by enabling the identification task to be automatic, so the task could be more speedy and better in terms of reliability through intelligently extracting and comparing with available information on allergens. The real time alert-signaling procedure is created as a means of comfort and a pro-active barrier that helps the user choose safely what to buy, instead of having to face the aftermaths later. Through identifying inconspicuous allergens like milk added in a spicy snack or tree-nuts in sauce, the undertaking has an educational function, helping the user be more careful with their consumption. It also protects users from cross reactive allergens which are materials triggering undesirable bodily-reactions as they are similar in terms of bio-chemical structures to familiar allergens, hence providing an integral allergen-management application for a user who has complicated dietary-restrictions.

4. Methodology

4.1 System Architecture

Project Safe Savor is designed as a Google Chrome extension for the ease of the users and to elevate the user experience. The current version of the project only focuses on the Walmart, a famous e-commerce service in the US. The three major parts that are encompassed by the system architecture are: User Interface, Data Processing Module, and Alert Mechanism.

The User Interface part represents the GUI of the input form and alert box. The Data Processing Module uses the DOM parsing methods to read the contents under the ingredient element of the Walmart product page and matches the read contents with the stored allergen list. The Alert Mechanism is responsible for triggering an alert box that warns the user about the presence of the allergen contents in the product.

4.2 Data Collection and Management

The primary data for the process, the user allergen list, is retrieved through a simple popup form and stores the information locally in the user's machine.

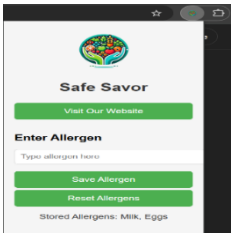

Fig – 2: Allergen input popup form

With this allergen list, there is an additional resource in the format of JSON files:

4.2.1 Alternative Name JSON

Fig – 3: Alternative_Name.json

```
{
    "Milk": [
        "Milk", "Whole milk", "Skim milk", "Low-fat milk", "Fat-free milk", "Lactose-free milk",
        "Butter", "Butter fat", "Butter oil",
        "Cheese", "Cheddar", "Brie", "Feta", "Paneer", "Ricotta", "Cottage cheese",
        "Yogurt", "Probiotic yogurt",
        "Cream", "Heavy cream", "Sour cream", "Cream powder",
        "Ghee", "Buttermilk", "Condensed milk", "Evaporated milk",
        "Milk powder", "Dried milk solids",
        "Whey", "Whey protein", "Whey powder", "Hydrolysates",
        "Casein", "Caseinates", "Casein hydrolysates", "Milk protein concentrate", "Milk protein isolate",
        "Lactose", "Lactalbumin", "Lactoglobulin", "Lactoferrin", "Lactulose",
        "Artificial butter flavor", "Artificial cheese flavor",
        "Ice cream", "Pudding", "Custard",
        "Coffee creamers", "Chocolate with milk"
    ],
    "Eggs": [
        "Egg", "Egg whites", "Egg yolk", "Albumin",
        "Ovalbumin", "Ovovitellin", "Globulin", "Lysozyme",
        "Lecithin (egg-derived)"
    ],
    "Peanuts": [
        "Peanut", "Groundnut", "Arachis", "Peanut oil",
        "Peanut butter", "Peanut flour", "Cold-pressed peanut oil",
        "Satay sauce"
    ],
    "Tree Nuts": [
        "Almond", "Walnut", "Cashew", "Pistachio",
        "Pecan", "Hazelnut", "Brazil nut", "Macadamia nut",
        "Marzipan"
    ],
    "Soy": [
        "Soy", "Soybean", "Soy protein", "Soy lecithin",
        "Tofu", "Tempeh", "Miso", "Edamame",
        "Soy milk", "Soy sauce"
    ],
    "Sesame": [
        "Sesame seed", "Sesame oil", "Tahini",
        "Gingelly", "Benne", "Sesamol", "Sesamum indicum"
    ],
    "Wheat": [
        "Wheat", "Wheat flour", "Gluten", "Wheat starch",
        "Semolina", "Farina", "Couscous", "Durum",
        "Spelt", "Einkorn"
    ],
    "Shellfish": [
        "Shrimp", "Crab", "Lobster", "Prawn",
        "Crayfish", "Mollusks", "Clams", "Oysters",
        "Scallops", "Snails"
    ],
    "Fish": [
        "Salmon", "Tuna", "Cod", "Haddock",
        "Anchovy", "Sardine", "Mackerel", "Tilapia",
```


There exists a problem with all the unrecognisable nick names or alternative names of each ingredient. To make sure that our extension recognises the allergic ingredient even with their nick names, we have created a JSON file or a dictionary, that contains all the nick names of each and every product. For instance, “milk” can also be addressed as “casein”, “whey”, “lactose” and so on. By doing this, we can escape the accidental omissions.

In fig 3, the dictionary that was used in this project can be observed. It contains the alternative names of the globally listed nine allergens that pose most of the threat.

4.2.2 Cross-Reactive Allergen JSON

The cross-reactivity study states that intertwined allergens exist. For example, the chances of a person who is allergic to latex being allergic to bananas or avocados as well are high. This concept of cross-reaction is being applied in this project by creating a similar JSON file with the allergens, their cross-reactive allergens, and the risk of reaction in percentile.

In fig 4, the dictionary that was used in this project can be observed. It contains the cross-reactive allergens of the respective Big 9 allergens. This data is from a study conducted by the NIH – National Institute of Health [4].

Fig – 4: cross_reactivity.json

```
{
    "Milk": {
        "Goat milk": 90,
        "Mare milk": 4,
        "Beef": 10
    },
    "Peanut": {
        "Other legumes": 5,
        "Tree nuts": 35,
        "Lupin": 16.5
    },
    "Lentil": {
        "Chickpea": 81,
        "Green pea": 81
    },
    "Tree nuts": {
        "Pistachio-cashew": 67,
        "Walnut-pecan": 87.5,
        "Peanut or other tree nuts": 40
    },
    "Fish": {
        "Other fish": 50
    },
    "Eggs": {
        "Quail eggs": 20,
        "Duck eggs": 15
    },
    "Shellfish": {
        "Crustacean-mollusk": 15,
        "Mollusk-mollusk": 50,
        "Crustacean-crustacean": 50
    },
    "Wheat": {
        "Rye": 20,
        "Barley": 20,
        "Rice": 5,
        "Oats": 5,
        "Corn": 5
    },
    "Beef": {
        "Cow's milk": 90
    }
}
```

4.3 Data Processing and Matching

Once a user submits their allergen preferences, the extension initiates a structured data processing routine to analyze the ingredient list extracted from the product page. The process begins with ingredient extraction and cleaning, where the content is parsed from the DOM and standardized—converted to lowercase and stripped of special characters—to ensure uniformity. Next, the cleaned ingredient list is directly compared with the user’s specified allergens to flag exact matches. To broaden detection, the system also performs indirect allergen matching by cross-referencing two JSON files: one containing alternative names for allergens and another identifying cross-reactive substances. This ensures that synonymous and related allergens, even if not explicitly named, are also identified. By layering direct and indirect comparison methods, the extension offers a robust and thorough allergen detection system that significantly minimizes the risk of accidental exposure.

5. Workflow

The process commences when the user navigates to any of the Walmart food product pages. By the time the page is completely loaded, the work of the extension is started in the background. It first starts with the data extracting process to access the ingredients section by DOM parsing. After obtaining an array of ingredients, each and every individual element of the array is compared or matched with the stored allergen list as well as their respective alternative names and cross-reactive allergens list with the help of the JSON files [ref: Fig-3 & 4].

If one or more matches are found, the extension stores the information temporarily, that is, until the user exits the product page. In the event of the user clicking the “add to cart” button, the function is triggered and produces an alert with the help of the temporarily stored information. This method of processing data in the background dynamically results in lightning speed. If at all no ingredient is matched with the stored allergen list, the extension does not react to any of the events happening in the page like adding the product to the cart or buying the product. This entire process is made possible with the help of the smart choice of technology stack that is both simple and light weight.

6. Technology Stack

The technological components that were used to build *Safe Savor* are as follows:

a. **JavaScript** was used for DOM parsing, data extraction, and functions to compare the extracted data with the stored allergens.
b. **HTML and CSS** was used for the structuring and design of allergen input form.
c. **Chrome API** was used for the extension deployment and integration with the chrome engine. It was also responsible for gaining access permissions of the Walmart product pages.
d. **JSON** was used for formatting the extracted allergens and to store the alternative names of the allergens & their cross-reactive allergen list in a structured way.
e. **Manifest File (Manifest v3)** was used for the extension configuration and to manage the permissions, as per the standards of Chrome.

These technologies were chosen for their simplicity and flexibility, which directly contributes to make the extension very light-weight and fast.

7. Limitations and Assumptions

In spite of its efficiency, the allergen-detection methodology put forward has a few constraints and is based on particular presumptions:

I. Platform-Specific: The extension is particularly structured to suit the site of Walmart and might not work as intended on the rest of the electronic commerce sites.
II. Dependence on Accurate Ingredient Lists: The methodology depends upon the details regarding the ingredients given on Walmart webpages displays the products being accurate and complete. If the information on the ingredients of products are not complete or correct, the methodology could not guarantee being accurate.
III. Browser Dependency: The extension is structured to suit the Google Chrome browser, and the prospect of whether it would be compatible with every other browser remains untested.

The above-mentioned constraints are recognized for the sake of ensuring transparent disclosure and helping the user comprehend the capacity of the extension.

8. Results

8.1 Performance Evaluation

The Safe Savor extension was meticulously put to trial on different product-pages in the Walmart site to appraise its efficiency in identifying allergens with accuracy. The extension invariably detected the allergens disclosed in the ingredient-list, even the ones disclosed using different terminologies or cross-reactive classifications. The frameworks listed below were utilized to appraise its efficiency:

Allergen stored: Milk

Case 1: No Allergen Present:
The users' shopping experience were not interrupted by unnecessary alerts for acknowledging the absence of the allergens.

Case 2: Direct Allergen Detection:
An alert was triggered when the tester attempted to add a milk carton to the cart as in the fig 5.

Fig 5: Direct Allergen Detection – Alert popup

Case 3: Alternative Name Recognition:
An alert was triggered when the tester attempted to add a heavy cream sachet to the cart as in the Fig 6. This was made possible with the help of the alternative name JSON, confirming the successful execution of the processing step.

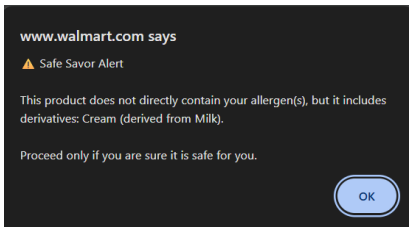

Fig 6: Alternative Name Recognition – Alert Popup

Case 4: Cross-Reactive Allergen Detection:
An alert was triggered when the tester attempted to add a unit of ground beef to the cart as in the Fig 7. This was made possible with the help of the cross-reactive allergen JSON, confirming the successful execution of the processing step.

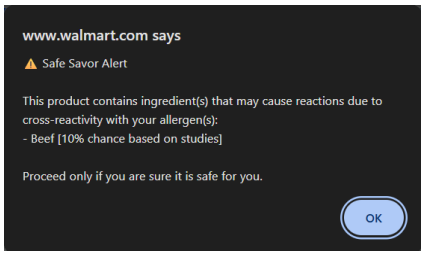

Fig 7: Cross-Reactive Allergen Detection – Alert Popup

8.2 Speed and Efficiency

The functioning of the extension was maximized for less delay. Extracting Ingredients and allergen-matching were done within a second, assuring a flawless user-experience. Storing the JSON-files locally made it possible to instantly look up information, so that external API calls would not be necessary, and making it speedy and private as well.

8.3 Error Handling

Based on the tests conducted on all sorts of product pages, these are the observations in regards with the error handling:

1. Some product pages were found without any ingredient section. Those were completely skipped by the extension without triggering any alert, unnecessary crashes.
2. The extension was efficient enough to handle Walmart's pages with dynamically loaded content, as the extension is dynamic in nature too.
3. The extension has also processed the unstructured or imprecise ingredients without throwing any errors or crashing.

8.4 Future Scope

a. **Expansion of Allergen Database:** Subsequent versions can stretch to accommodate, along with the Big-9 allergens, rarer allergens and allergens specific to certain regions, satisfying various groups of people throughout the world.

b. **Multi-Platform Support**: The service of the extension could be extended not just to Walmart but also to similar considerably large-scale grocery-retailers and electronic commerce sites, making it more useful and impactful.

c. **Incorporation of Machine Learning:** Using Artificial Intelligence and machine-learning would be helpful in predicting possible risk of allergens on the basis of shopping-habits, suggesting more harmless options, and personalizing suggestions eventually.

d. **Community and Feedback Features:** The information base could be made more accurate and trustworthy for users by developing a user-community for exchanging information about their experience, review, and feedbacks on allergen-detection efficiency.

9. Conclusion

The Project *Safe Savor* has introduced a much easier method in comparison to the services in the market to detect allergens in the food items. With no external storage of data, it promises safe browsing and personalised service at the same time. It guarantees efficiency with the string of processes to detect the allergens, paying a lot of attention to every minute details from the data processing phase to the alert mechanism phase.

In Conclusion, *Safe Savor* is a small step towards a safer and healthier world where each and every consumer can make choices without being mindful of the outcomes. We believe that small innovative sparks like this would ignite a bigger game changing technologies in the future.

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