Vulnerability Assessment & Penetration Testing Report

Target Application : OWASP Juice Shop

Overall Risk Rating:

CRITICAL

Security Standards: OWASP 10 2025)
Document Version: 1.0 Final
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Chief Security Officer **CyberVault**	**OWASP Juice Shop** **Stakeholders**
Signature	Signature

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1. Executive Summary

1.1 Overall Security Posture

A comprehensive security assessment was conducted on the **OWASP Juice Shop** web application. The assessment utilized a hybrid methodology combining automated scanning with manual penetration testing techniques.

The application currently exhibits a **CRITICAL** risk posture. The testing team identified systemic failures in core security controls, including broken access control mechanisms, lack of input sanitization, and weak authentication enforcement. These vulnerabilities would allow an external attacker to compromise the confidentiality, integrity, and availability of the application and its user data.

1.2 Risk Overview

The assessment identified a total of **24 vulnerabilities**. The most critical issues allow for full administrative account takeover via SQL Injection, execution of arbitrary client-side code (XSS), and unauthorized access to other users' data (IDOR).

1.3 Severity Distribution

Severity	Count	Description
Critical	5	Vulnerabilities that allow immediate system compromise or massive data theft.
High	15	Vulnerabilities that provide significant unauthorized access or data exposure.
Medium	4	Vulnerabilities that leak information or degrade security posture.
Low	0	Minor issues or best-practice deviations.

1.4 Business Impact Summary

- **Financial Loss:** Exploitation of business logic flaws (e.g., manipulating basket prices) could lead to direct revenue loss.
- **Reputational Damage:** The exposure of user passwords and personal data via API leaks would severely damage user trust.
- **Operational Disruption:** SQL Injection attacks could be used to delete data or corrupt the database, causing service downtime.

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2. Engagement Overview

Attribute	Details
Application Name	OWASP Juice Shop
Application Type	E-Commerce Web Application
Assessment Type	Vulnerability Assessment & Penetration Testing (Black Box)
Testing Methodology	Manual Exploitation & Automated Scanning
Compliance Standard	OWASP Top 10 (2025)

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3. Application Information

3.1 Functionality

OWASP Juice Shop is an e-commerce platform allowing users to browse products, manage shopping baskets, post reviews, and purchase items. It includes user registration, login, and administrative dashboards.

3.2 User Roles

- **Guest:** Can browse products and register.
- **Standard User:** Can manage profile, basket, and place orders.
- **Administrator:** Has elevated privileges to view all users and manage the platform.

3.3 Technology Stack

- **Frontend:** AngularJS
- **Backend:** Node.js (Express framework)
- **Database:** SQLite (inferred from error logs)
- **Authentication:** JSON Web Tokens (JWT)
- **Dependencies:** NPM ecosystem

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4. Severity Rating Methodology

- **Critical:** Exploitation is straightforward and results in root-level compromise, authentication bypass, or massive data exfiltration. Immediate remediation is required.
- **High:** Exploitation is difficult but severe, or easy but limited in scope (e.g., specific user compromise). remediation required within 1 week.
- **Medium:** Exploitation requires special conditions or results in information leakage that aids further attacks. Remediation required within 1 month.

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5. Vulnerability Summary Table

ID	Vulnerability Name	Severity	OWASP 2025 Category
01	SQL Injection (Authentication Bypass)	**Critical**	A05: Injection
02	Weak Authentication Enforcement	**Critical**	A07: Authentication Failures
03	Sensitive Data Exposure via API	**Critical**	A04: Cryptographic Failures
04	Insecure JWT Token Handling	**Critical**	A04: Cryptographic Failures
05	Reflected Cross-Site Scripting (XSS)	**Critical**	A05:2025 – Injection
06	Vertical Privilege Escalation to Admin	**High**	A01:2025 – Broken Access Control
07	Insecure Direct Object Reference (IDOR)	**High**	A01:2025 – Broken Access Control
08	Insecure Third-Party Dependencies	**High**	A03: Supply Chain Failures
09	Forced Browsing	**High**	A01:2025 – Broken Access Control
10	Horizontal Privilege Escalation	**High**	A01:2025 – Broken Access Control
11	Insecure Cross-Origin Resource Sharing	**High**	A02: Security Misconfiguration
12	Excessive Data Exposure	**High**	A04: Cryptographic Failures
13	DOM-Based Cross-Site Scripting (XSS)	**High**	A05: Injection
14	Rate Limiting Failure	**High**	A07: Authentication Failures
15	Weak Password Policy	**High**	A07: Authentication Failures
16	Client-Side Trust Issues	**High**	A01: Broken Access Control
17	JWT Mismanagement	**High**	A07: Authentication Failures
18	No Logging & Monitoring	**High**	A09: Logging Failures
19	No Monitoring of Abnormal API Behavior	**High**	A09: Logging Failures
20	Cross-Site Request Forgery (CSRF)	**High**	A01: Broken Access Control
21	Verbose Error Messages Disclosure	**Medium**	A10: Exception Handling
22	Missing Security Headers	**Medium**	A02: Security Misconfiguration
23	Improper Exception Handling	**Medium**	A10: Exception Handling
24	Information Leakage Through Error	**Medium**	A10: Exception Handling

6. Detailed Vulnerability Findings

6.1 Critical Severity Findings

VULN-01: SQL Injection (Authentication Bypass)

Severity: CRITICAL

OWASP Category: A05:2025 – Injection

Affected Component: `/rest/user/login`

Description: The application constructs SQL queries dynamically using user-supplied input strings. In the login form, the email field is concatenated directly into the database query. By inputting a malicious payload like `' OR 1=1--`, the attacker alters the query logic to "Return true if the email is empty OR 1 equals 1". The `--` comments out the rest of the query (the password check). This forces the database to return the first record in the `Users` table, which is invariably the Administrator.

Impact:

- **Full System Compromise:** Immediate, unauthenticated access to the Administrator account.
- **Data Breach:** Attackers can potentially use UNION-based injection to extract all data from the database.

PoC (Proof of Concept):

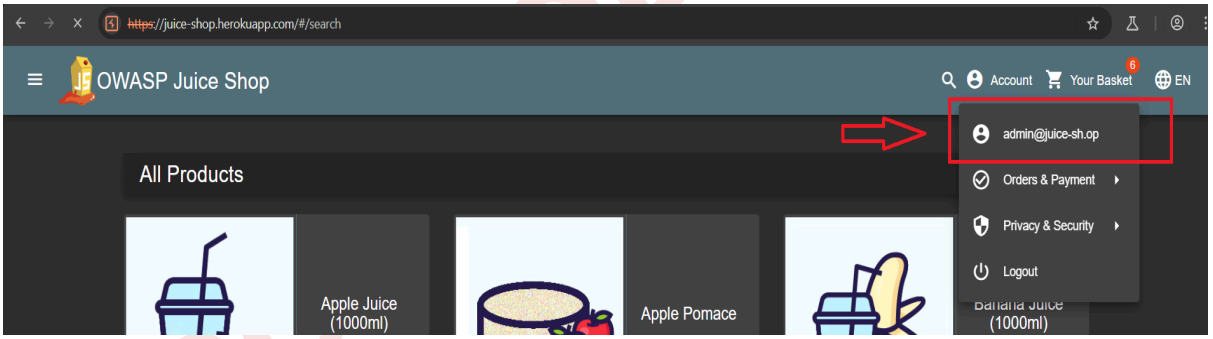
- **Payload Injection:**

```
POST /rest/user/login HTTP/1.1
Host: juice-shop.herokuapp.com
Cookie: language=en; welcomebanner_status=dismiss; cookieconsent_status=dismiss
; continueCode=
aXuEhNtEioS3t3cKIpTXsrFrfxHvhgtNIPTjVuKjtPVIqoTRruBnhbntMWIYyF0vSxvtE7cyNfQ2SmK
UgVuERhVRt5YHywszlFVrfqVHJDhWqI7rCqVspw
Content-Length: 42
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36
(KHTML, like Gecko) Chrome/130.0.6723.70 Safari/537.36
X-User-Email: hello@gmail.com
Content-Type: application/json
Origin: https://juice-shop.herokuapp.com
Referer: https://juice-shop.herokuapp.com/
Connection: keep-alive

{
  "email":"' OR 1=1-- ",
  "password":"human"
}
```

- **Admin Token Response:**

```
HTTP/1.1 200 OK
Access-Control-Allow-Origin: *
Content-Length: 799
Content-Type: application/json; charset=utf-8
Date: Mon, 12 Jan 2026 17:07:34 GMT
Etag: W/"31f-QV8Ac/v9XIkQSOLg8LGX8wo8Ngg"
Feature-Policy: payment 'self'
Nel: {"report_to":"heroku-nel","response_headers":["Via"],"max_age":3600,"succes
Report-To: {"group":"heroku-nel","endpoints":[{"url":"https://nel.heroku.com/re
Reporting-Endpoints: heroku-nel="https://nel.heroku.com/reports?s=HUTR%2FojRt%2
Server: Heroku
Vary: Accept-Encoding
Via: 1.1 heroku-router
X-Content-Type-Options: nosniff
X-Frame-Options: SAMEORIGIN
X-Recruiting: /#/jobs

{
  "authentication":{
    "token":"eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiJ9.eyJzdGF0dXMiOiJzdWNjZXNzIiwiZ
    g6NTkuMDk2ICswMDowMCIsImRlbGV0ZWRBdCI6bnVsbH0sImlhdCI6MTc20DIzNzY1NH0.pXHIH
    "bid":1,
    "umail":"admin@juice-sh.op"
  }
}
```

- **Admin Access Granted:**



Remediation:

- **Parameterized Queries:** Use Prepared Statements for ALL database queries. This ensures input is treated as data, not executable code.
- **ORM Security:** Ensure the ORM (Sequelize) is used correctly with bind parameters (e.g., `replacements: { email: input }`).
- **Input Validation:** Enforce strict email format validation on the server side.

VULN-02: Weak Authentication Enforcement

Severity: CRITICAL

OWASP Category: A07:2025 – Authentication Failures

Affected Component: API Authorization

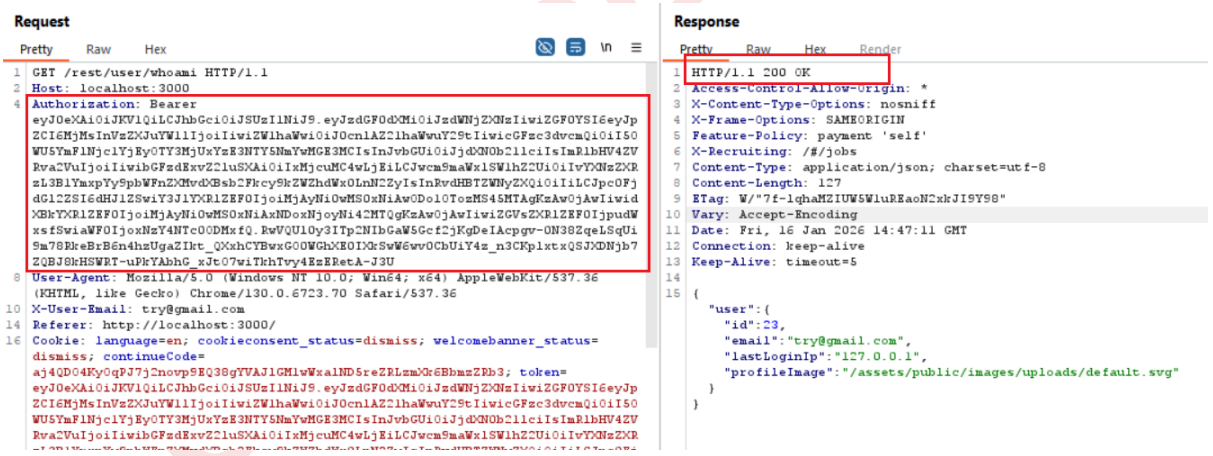
Description: The application accepts authentication tokens without performing strict validation checks. In some cases, it may accept tokens that are expired, or tokens signed with a known/weak secret (e.g., "None" algorithm or default secrets). It effectively assumes "If a token is present, the user is valid."

Impact:

- **Auth Bypass:** Attackers can forge tokens to impersonate users.
- **Zombie Sessions:** Expired sessions remain active, increasing the window of opportunity for session hijacking.

PoC (Proof of Concept):

- **Response with Weak Token Validation:**



Remediation:

- **Verify Signature:** Ensure the backend cryptographically verifies the JWT signature on *every* request.
- **Check Expiration:** Strictly enforce the `exp` (expiration) claim.
- **Algorithm Whitelist:** Only accept strong algorithms (e.g., RS256) and reject the "None" algorithm.

VULN-03: Sensitive Data Exposure via API Response

Severity: CRITICAL

OWASP Category: A04:2025 – Cryptographic Failures

Affected Component: `/rest/user/whoami`

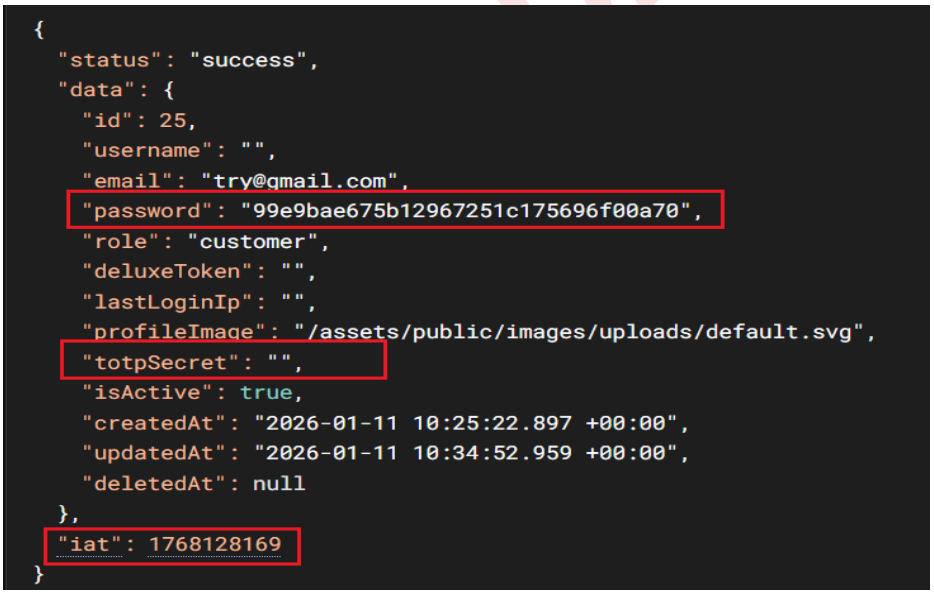
Description: The `/rest/user/whoami` endpoint, which is used to retrieve the current user's profile, returns the *entire* database record for the user. This includes highly sensitive fields such as the MD5 password hash (`password`), the TOTP secret key (`totpSecret`), and internal ID. This is a failure to sanitize the API response object.

Impact:

- **Account Compromise:** Exposure of the password hash allows attackers to crack the password offline.
- **MFA Bypass:** Exposure of the `totpSecret` allows an attacker to generate valid 2FA codes, bypassing Multi-Factor Authentication.

PoC (Proof of Concept):

- **Password Hash & TOTP Secret Leak:**



Remediation:

- **Use DTOs:** Implement Data Transfer Objects (DTOs) to explicitly define which fields are sent to the client (e.g., `username`, `email`, `profilePic`).
- **Exclude Sensitive Fields:** Configure the ORM (Sequelize) to exclude `password` and `totpSecret` from default query results.

VULN-04: Insecure JWT Token Handling

Severity: CRITICAL

OWASP Category: A04:2025 – Cryptographic Failures

Affected Component: Authentication Token

Description: The JSON Web Token (JWT) issued by the application contains sensitive Personally Identifiable Information (PII) within its payload, including the user's email address and internal database ID. Furthermore, the token is stored in LocalStorage or an insecure cookie, making it accessible to JavaScript (and thus vulnerable to XSS theft).

Impact:

- **Privacy Violation:** Anyone who intercepts the token can Base64 decode it to read the user's email.
- **Session Hijacking:** If the token is stolen via XSS, the attacker gains full access to the account.

PoC (Proof of Concept):

- **Decoded JWT Payload:**

```
HTTP/1.1 200 OK
Access-Control-Allow-Origin: *
Content-Length: 790
Content-Type: application/json; charset=utf-8
Date: Sun, 11 Jan 2026 10:35:35 GMT
Etag: W/"316-5W9apo/plFoF8DEFkRD9HIGn9gM"
Feature-Policy: payment 'self'
Nel:
{"report_to":"heroku-nel","response_headers":["Via"],"max_age":3600,"success_fraction":0.01,"failure_fraction":0.1}
Report-To:
{"group":"heroku-nel","endpoints":[{"url":"https://nel.heroku.com/reports?s=GM70fc9jQYEKtAz5mvB9%2F8ZHdNVRXTLeHhe2CoFRjAY%3D\u0026sid=812dcc77-0bd0-43b1-a5f1-b25750382959\u0026ts=1768127735"}],"max_age":3600}
Reporting-Endpoints:
heroku-nel="https://nel.heroku.com/reports?s=GM70fc9jQYEKtAz5mvB9%2F8ZHdNVRXTLeHhe2CoFRjAY%3D&sid=812dcc77-0bd0-43b1-a5f1-b25750382959&ts=1768127735"
Server: Heroku
Vary: Accept-Encoding
Via: 1.1 heroku-router
X-Content-Type-Options: nosniff
X-Frame-Options: SAMEORIGIN
X-Recruiting: /#/jobs

{
  "authentication":{
    "token":
    "eyJ0eXAiOiJKV1QiLCJhbGci0iJSUzI1NiJ9.eyJzdGF0dXMi0iJzdWNjZXNzIiwiZGF0YSI6eyJpZCI6MjUsInVzZXJuYW1lIjoiIiwiZWlhaWwi0iJ0cnlAZ2lhaWwuY29tIiwicGFzc3dvcmQi0iI50WU5YmFlNjc1YjEy0TY3MjUxYzE3NTY5NmYwMGE3MCIsInJvbGUi0iJjdXN0b21lciIsImRlbHV4ZVRva2VuIjoiIiwibGFzdExvZ2luSXAi0iIiLCJwcm9maWxlSW1hZ2UiOiIvYXNzZXRzL3B1YmxpYy9pbWFnZXMvdXBsb2Fkcy9kZWZhdWx0LnN2ZyIsInRvdHBTZWNyZXQi0iIiLCJpc0FjdG12ZSI6dHJ1ZSwiY3JlYXRlZEF0IjoiMjAyNi0wMS0xMSAxMDoyNToyMi440TcgKzAw0jAwIiwidXBkYXRlZEF0IjoiMjAyNi0wMS0xMSAxMDozNDolMi45NTkgKzAw0jAwIiwiZGVsZXRlZEF0IjpudWxsfSwiaWF0IjoxNzY4MTI3NzM1fQ.KamkAFHlJbuUz70NjyKwTal_jp0msKDDIaf2cipiXQ_zasmZ6myjhjlAXNMYwJyXU8aTyVRP4kxHihlm0zGFDmhCBxgkZSrFYASOMZK2qpq_kh53Fg-SbIgm7vCe0qd0h0eUlwEwVK5P3Fi7kNSrKfh0BHoMjUsJGGnvXMrJbmo",
    "bid":7,
    "umail":"try@gmail.com"
  }
}
```

Remediation:

- **Opaque Tokens:** Avoid putting PII in the token. Use a random session reference ID if possible.
- **Secure Storage:** Store the JWT in an `HttpOnly`, `Secure`, `SameSite=Strict` cookie to prevent client-side access (XSS mitigation).
- **Encryption:** If data must be in the token, encrypt the JWT (JWE) instead of just signing it (JWS).

VULN-05: Reflected Cross-Site Scripting (XSS)

Severity: CRITICAL

OWASP Category: A05:2025 – Injection

Affected Component: `/search`

Description: Reflected XSS occurs when an application receives data in an HTTP request (like a search term) and includes that data within the immediate response in an unsafe way.

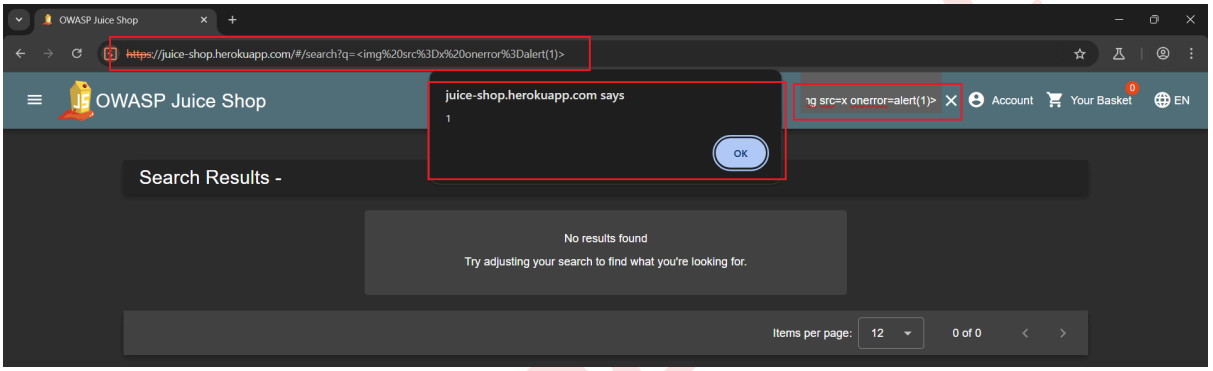
The Juice Shop search bar echoes the user's input directly into the HTML without escaping special characters. An attacker can craft a link containing malicious JavaScript (e.g., `<script>alert(1)</script>`). If a victim clicks this link, the script executes in their browser.

Impact:

- **Session Hijacking:** The script can send the user's session cookies to the attacker.
- **Phishing:** The script can redraw the page to look like a fake login prompt.

PoC (Proof of Concept):

- **XSS Alert Box Execution:**



Remediation:

- **Context-Aware Encoding:** Encode all user-supplied data before rendering it in the browser.
- **Content Security Policy (CSP):** Implement a CSP that disallows inline scripts.

6.2 High Severity Findings

VULN-06: Vertical Privilege Escalation to Administrator

Severity: HIGH

OWASP Category: A01:2025 – Broken Access Control

Affected Component: `/api/Users`

Description: Vertical Privilege Escalation occurs when a lower-privileged user accesses functions reserved for higher-privileged roles. The `/api/Users` endpoint, which returns a list of all registered users, lacks a role verification check. A standard "customer" account can query this endpoint and retrieve the full user database, including the Administrator's email and details. The backend logic assumes that only the UI would hide this link, failing to protect the API route itself.

Impact:

- **Confidentiality:** Complete exposure of the user database (PII leakage).
- **Security Posture:** Attackers can identify the admin email address (`admin@juice-sh.op`) to target for brute-force or phishing attacks.

PoC (Proof of Concept):

- **Standard User Requesting Admin Data:**

```
GET /api/Users/ HTTP/1.1
Host: juice-shop.herokuapp.com
Authorization: Bearer
eyJ0eXAi0iJKV1QiLCJhbGci0iJSUzI1NiJ9.eyJzdGF0dXMi0iJzdWNjZXNzIiwiZGF0YSI6eyJpZC
I6MjUsInVzZXJuYW1lIjoiIiwiZW1haWwi0iJ0cnlAZ21haWwuY29tIiwicGFzc3dvcmQi0iI50WU5Y
mFlNjc1YjEy0TY3MjUxYzE3NTY5NmYwMGE3MCIsInJvbGUi0iJjdXN0b21lciIsImRlbHV4ZVRva2Vu
IjoiIiwibGFzdExvZ2luSXAi0iIiLCJwcm9maWxlSW1hZ2Ui0iIvYXNzZXRzL3B1YmxpYy9pbWFnZXM
vdXBsb2Fkcy9kZWZhdWx0LnN2ZyIsInRvdHBTZWNyZXQi0iIiLCJpc0FjdGl2ZSI6dHJ1ZSwiY3J1YX
RlZEF0IjoiMjAyNi0wMS0xMCAxMDo10To0My4zNDYgKzAw0jAwIiwidXBkYXRlZEF0IjoiMjAyNi0wM
S0xMCAxMTo0NzowNy4zNjcgKzAw0jAwIiwiZGVsZXRlZEF0IjpudWxsfSwiaWF0IjoxNzY4MDQ1NjQy
fQ.XYHtCFuc3cKcYyiGptz8TOMGK4kDJEEJCuFy_5mfcYQeluoEve06bNW_lu5Y2n-VY8VG0FXfh9UQ
uoE0Koh6GLHUiCmoYih_pA6yXtKWYKnvDNBJ1h7gd2emkb2A8Myu_g1H3VgR4yCFgI2V66cNx5QMtqD
antmyJ4PcDoFeaZU
X-User-Email: try@gmail.com
```

- **Response showing Admin Account:**

```
{
    "status":"success",
    "data":[
        {
            "id":1,
            "username":"",
            "email":"admin@juice-sh.op",
            "role":"admin",
            "deluxeToken":"",
            "lastLoginIp":"",
            "profileImage":"assets/public/images/uploads/defaultAdmin.png",
            "isActive":true,
            "createdAt":"2026-01-10T11:51:02.588Z",
            "updatedAt":"2026-01-10T11:51:02.588Z",
            "deletedAt":null
        },
        {
            "id":2,
            "username":"",
            "email":"jim@juice-sh.op",
            "role":"customer",
            "deluxeToken":"",
            "lastLoginIp":"",
            "profileImage":"assets/public/images/uploads/default.svg",
            "isActive":true,
            "createdAt":"2026-01-10T11:51:02.588Z",
            "updatedAt":"2026-01-10T11:51:02.588Z",
            "deletedAt":null
        },
        {
            "id":3,
            "username":"",
            "email":"bender@juice-sh.op",
            "role":"customer",
            "deluxeToken":"",
            "lastLoginIp":"",
            "profileImage":"assets/public/images/uploads/default.svg",
```


Remediation:

- **Role-Based Access Control (RBAC):** Implement a strict check: `if (user.role !== 'admin') return 403 Forbidden;`.
- **Route Protection:** Ensure all administrative routes are grouped and protected by a centralized administrative middleware.
- **Principle of Least Privilege:** Standard users should never have read access to the `Users` table.

VULN-07: Insecure Direct Object Reference (IDOR) on Basket Items

Severity: HIGH

OWASP Category: A01:2025 – Broken Access Control

Affected Component: `/api/BasketItems`

Description: Insecure Direct Object Reference (IDOR) occurs when an application provides direct access to objects based on user-supplied input. In this instance, the API endpoint for managing shopping basket items relies solely on the `BasketId` parameter sent in the request body/URL to identify which basket to modify. The application fails to verify on the server side whether the currently authenticated user is the legitimate owner of that `BasketId`. Consequently, a malicious actor can enumerate valid IDs and view or modify the shopping carts of other customers.

Impact:

- **Confidentiality:** Attackers can view the purchasing habits and cart contents of any user.
- **Integrity:** Attackers can inject items into other users' carts or remove existing items, causing confusion and potential financial fraud.
- **Business Impact:** Loss of customer trust and integrity of the ordering process.

PoC (Proof of Concept):

- **Step 1:** Intercept a request to view your own basket (ID 24).

```
GET /api/Products/24?d=Sat%20Jan%2010%202026 HTTP/1.1
Host: juice-shop.herokuapp.com
Authorization: Bearer eyJ0eXAi0iJKV1QiLCJhbGci0iJSUzI1NiJ9.eyJzdGF0dXMi0iJzdW
jYtMDEtMTAgMDk6NDI6MjUuMTE2ICswMDowMCIsImRlbGV0ZWRBdCI6bnVsbH0sImlhdCI6MTc20D
Accept-Language: en-US,en;q=0.9
Accept: application/json, text/plain, */*
X-User-Email: try@gmail.com
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHT
Referer: http://juice-shop.herokuapp.com/
Accept-Encoding: gzip, deflate, br
Cookie: language=en; welcomebanner_status=dismiss; cookieconsent_status=dismi
GVmYXVsdC5zdmciLCJ0b3RwU2VjcmV0IjoiIiwiaXNBY3RpdmUi0nRydWUsImNyZWF0ZWRBdCI6Ij
Connection: keep-alive
```

- **Step 2:** Modify the ID to 25 and observe the server returning another user's data.

```
GET /api/Products/25?d=Sat%20Jan%2010%202026 HTTP/1.1
Host: juice-shop.herokuapp.com
Authorization: Bearer eyJ0eXAi0iJKV1QiLCJhbGci0iJSUzI1NiJ9.eyJzdGF0dXMi0iJzdWN
jYtMDEtMTAgMDk6NDI6MjUuMTE2ICswMDowMCIsImRlbGV0ZWRBdCI6bnVsbH0sImlhdCI6MTc20DA
Accept-Language: en-US,en;q=0.9
Accept: application/json, text/plain, */*
X-User-Email: try@gmail.com
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTM
Referer: http://juice-shop.herokuapp.com/
Accept-Encoding: gzip, deflate, br
Cookie: language=en; welcomebanner_status=dismiss; cookieconsent_status=dismis
GVmYXVsdC5zdmciLCJ0b3RwU2VjcmV0IjoiIiwiaXNBY3RpdmUi0nRydWUsImNyZWF0ZWRBdCI6IjI
Connection: keep-alive
```


```
{
  "status":"success",
  "data":{
    "id":25,
    "name":"Fruit Press",
    "description":
    "Fruits go in. Juice comes out. Pomace you can send back to us for recycl
    ing purposes.",
    "price":89.99,
    "deluxePrice":89.99,
    "image":"fruit_press.jpg",
    "createdAt":"2026-01-10T09:08:37.494Z",
    "updatedAt":"2026-01-10T09:08:37.494Z",
    "deletedAt":null
  }
}
```


Remediation:

- **Implement Ownership Validation:** Modify the backend logic to compare the `userId` associated with the requested `BasketId` against the `userId` in the session token.
- **Use Indirect References:** Instead of sequential integer IDs (1, 2, 3), use cryptographically strong random UUIDs (e.g., `550e8400-e29b...`) that cannot be guessed.
- **Centralized Access Control:** Implement middleware that runs on every API call to verify `user == resource.owner`.

VULN-08: Insecure Third-Party Dependencies

Severity: HIGH

OWASP Category: A03:2025 – Software Supply Chain Failures

Affected Component: `package.json` / `node_modules`

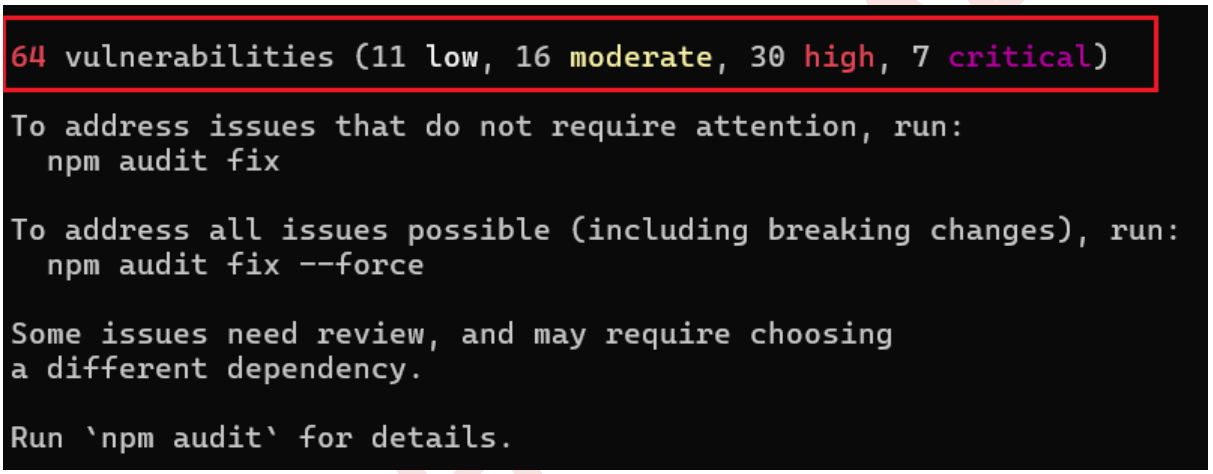
Description: Automated analysis using `npm audit` revealed that the application relies on 64 dependencies with known security vulnerabilities (CVEs), including 7 rated as Critical. These vulnerabilities exist in third-party libraries used by the application, meaning the application inherits their security flaws.

Impact:

- **RCE:** Some outdated libraries may contain Remote Code Execution vulnerabilities.
- **DoS:** Vulnerable parsers can often be crashed with malformed input (ReDoS).
- **Supply Chain Risk:** Attackers target known vulnerabilities in popular libraries to compromise downstream applications.

PoC (Proof of Concept):

- **NPM Audit Report:**



Remediation:

- **Audit Fix:** Run `npm audit fix` to automatically upgrade compatible versions.
- **Manual Upgrade:** Manually upgrade major versions for libraries with critical vulnerabilities.
- **SCA Tools:** Integrate Software Composition Analysis (SCA) tools like Snyk or Dependabot into the CI/CD pipeline to block builds with critical CVEs.

VULN-09: Forced Browsing (Sensitive Directory Exposure)

Severity: HIGH

OWASP Category: A01:2025 – Broken Access Control

Affected Component: `/ftp`, `/ftp/quarantine`

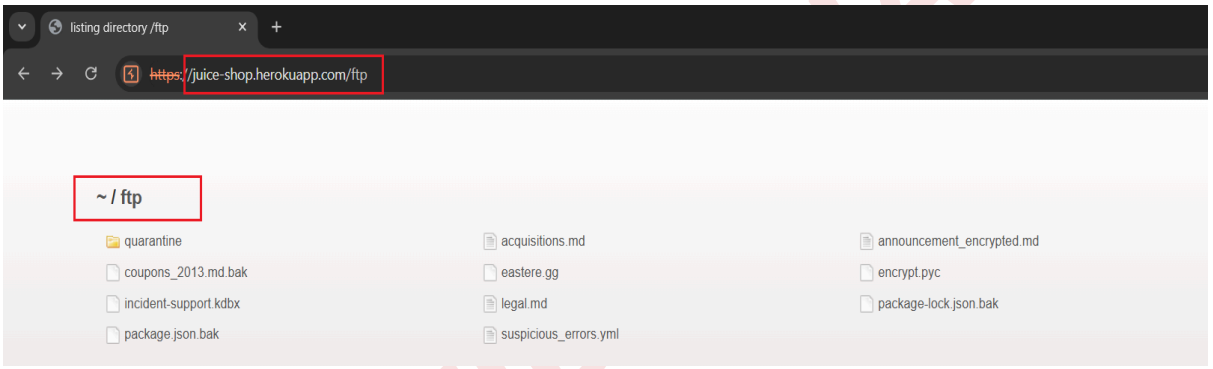
Description: Forced Browsing is an attack where the aim is to enumerate and access resources that are not referenced by the application, but are still accessible. The application exposes an `/ftp` directory which has "Directory Listing" enabled. This allows any user to see a list of files, including backups (`backup_2024.sql`, etc.) and a `/quarantine` folder containing potentially dangerous malware files used for testing.

Impact:

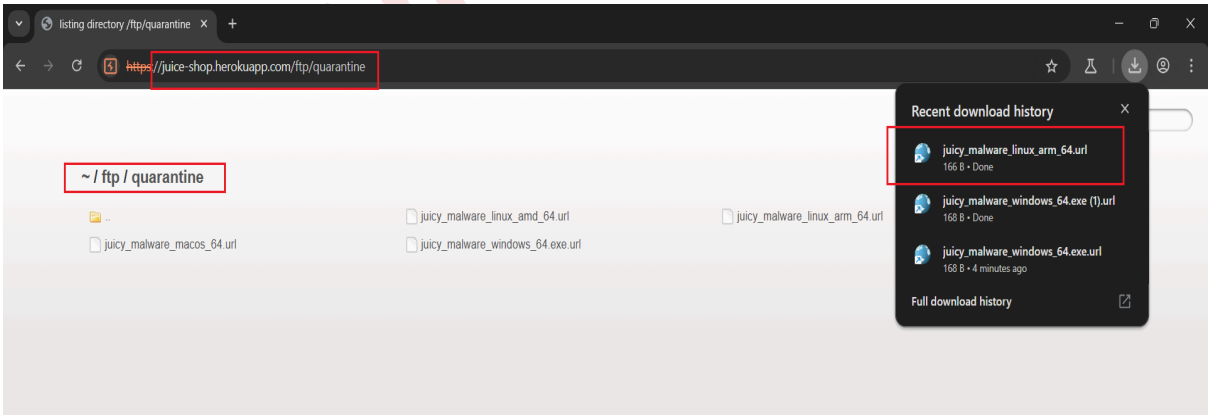
- **Confidentiality:** Exposure of intellectual property, database backups, or configuration files.
- **Safety:** The `/quarantine` folder exposes actual malware files, posing a risk to anyone who might accidentally download them.

PoC (Proof of Concept):

- **Accessing /ftp Directory:**



- **Accessing Malware in /quarantine:**



Remediation:

- **Disable Directory Listing:** Configure the web server (Nginx/Apache/Express) to disable auto-indexing of directories.

- **Restrict Access:** Use `.htaccess` or middleware to deny access to `/ftp` and other non-public directories for all unauthorized IPs.
- **Clean Up Production:** Remove all backup files, test files, and "quarantine" folders from the live production environment.

VULN-10: Horizontal Privilege Escalation (Basket Takeover)

Severity: HIGH

OWASP Category: A01:2025 – Broken Access Control

Affected Component: `/api/BasketItems`

Description: Similar to IDOR, Horizontal Privilege Escalation occurs when a user accesses resources of another user with the *same* privilege level. By manually changing the `BasketId` in a POST request, an attacker can add products to *someone else's* basket. This is distinct from IDOR because it involves a state-changing action (writing data) rather than just reading data.

Impact:

- **Integrity:** Attackers can corrupt the state of other users' sessions.
- **Financial Fraud:** Potential to manipulate inventory or cause users to purchase unintended items.

PoC (Proof of Concept):

- **Manipulating Basket ID in POST Request:**

```
GET /rest/basket/25 HTTP/1.1
Host: juice-shop.herokuapp.com
Cookie: language=en; welcomebanner_status=dismiss; cookieconsent_status=dismiss,
GVmYXVsdC5zdmciLCJ0b3RwU2VjcmV0IjoiIiwiaXNBY3RpdmUiOnRydWUsImNyZWF0ZWRBdCI6IjIwI
Authorization: Bearer eyJ0eXAi0iJKV1QiLCJhbGci0iJSUzI1NiJ9.eyJzdGF0dXMi0iJzdWNj;
jYtMDEtMTEgMDU6NDY6MjcuMDMwICswMDowMCIsImRlbGV0ZWRBdCI6bnVsbH0sImlhdCI6MTc20DExI
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML,
X-User-Email: try@gmail.com
Referer: https://juice-shop.herokuapp.com/
Connection: keep-alive
```

- **Successful Modification Response:**

Remediation:

- **Session Binding:** The application should ignore the `BasketId` sent from the client. Instead, it should look up the `BasketId` associated with the currently valid session token on the server side.
- **Input Validation:** Reject requests that attempt to submit IDs that do not match the session context.

VULN-11: Insecure Cross-Origin Resource Sharing (CORS)

Severity: HIGH

OWASP Category: A02:2025 – Security Misconfiguration

Affected Component: Global API Configuration

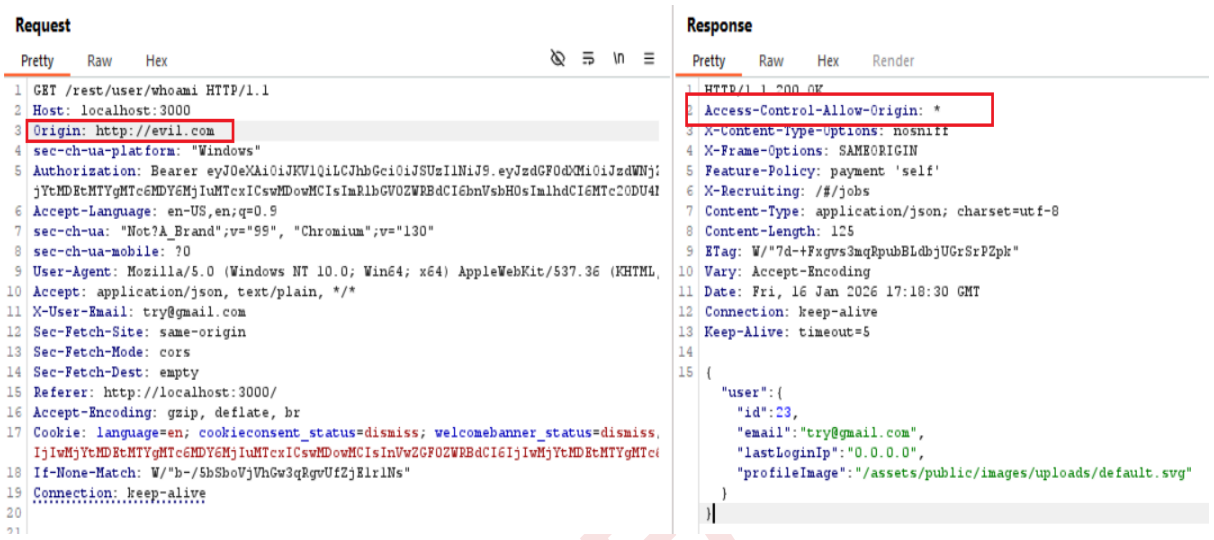
Description: The server is configured with the overly permissive header `Access-Control-Allow-Origin: *`. This wildcard configuration allows *any* website on the internet to make asynchronous requests (AJAX/Fetch) to the API and read the responses. This bypasses the Same-Origin Policy (SOP).

Impact:

- **Data Theft:** A malicious website (`evil.com`) can make authenticated requests to the application (if using Windows Auth or Client Certs) or read public data that should be restricted.
- **Attack Surface Expansion:** API endpoints are exposed to the entire web.

PoC (Proof of Concept):

- **Wildcard Origin Header:**



Remediation:

- **Whitelist Origins:** Explicitly list allowed domains (e.g., `https://juice-shop.herokuapp.com`).
- **Remove Wildcard:** Never use `*` in production environments, especially for APIs handling sensitive data.
- **Vary Header:** Ensure the `Vary: Origin` header is set to prevent caching issues.

VULN-12: Excessive Data Exposure

Severity: HIGH

OWASP Category: A04:2025 – Cryptographic Failures

Affected Component: API Responses

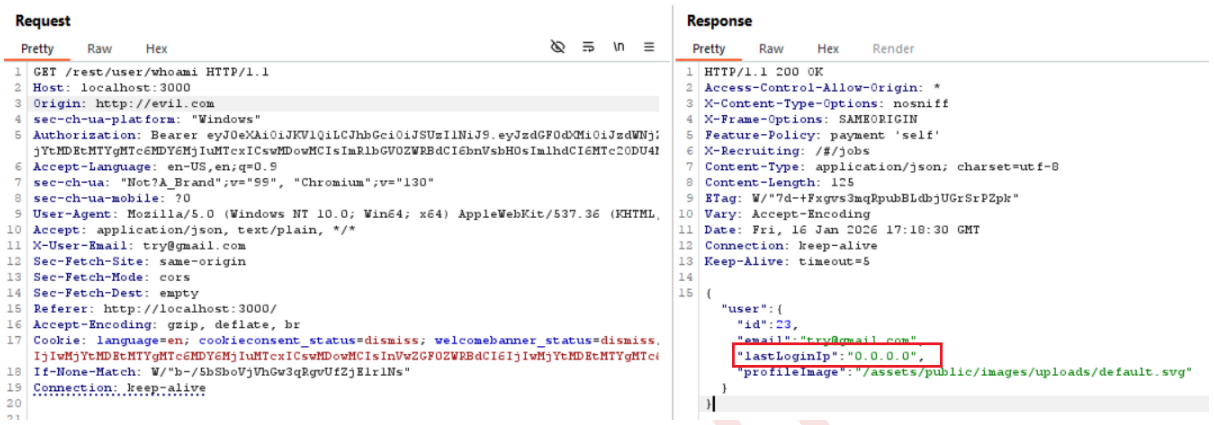
Description: Similar to VULN-09, multiple API endpoints return more data than is rendered by the UI. The server relies on the frontend code to filter and display only the relevant data. However, an attacker inspecting the network traffic can see the full JSON objects, including fields like `lastLoginIp`, `createdAt`, `updatedAt`, and `isActive`.

Impact:

- **Intelligence Gathering:** Attackers can profile users, identifying account age, activity patterns, and IP addresses.
- **Attack Surface:** Unused hidden fields (like `isActive`) might be manipulable in PUT/POST requests (Mass Assignment).

PoC (Proof of Concept):

- **JSON Response with Unused Fields:**



Remediation:

- **Backend Filtering:** Ensure the API only returns the exact data needed for the view.
- **Schema Validation:** Use response schemas (e.g., JSON Schema) to strictly define valid output formats.

VULN-13: DOM-Based Cross-Site Scripting (XSS)

Severity: HIGH

OWASP Category: A05:2025 – Injection

Affected Component: Client-Side Search Logic

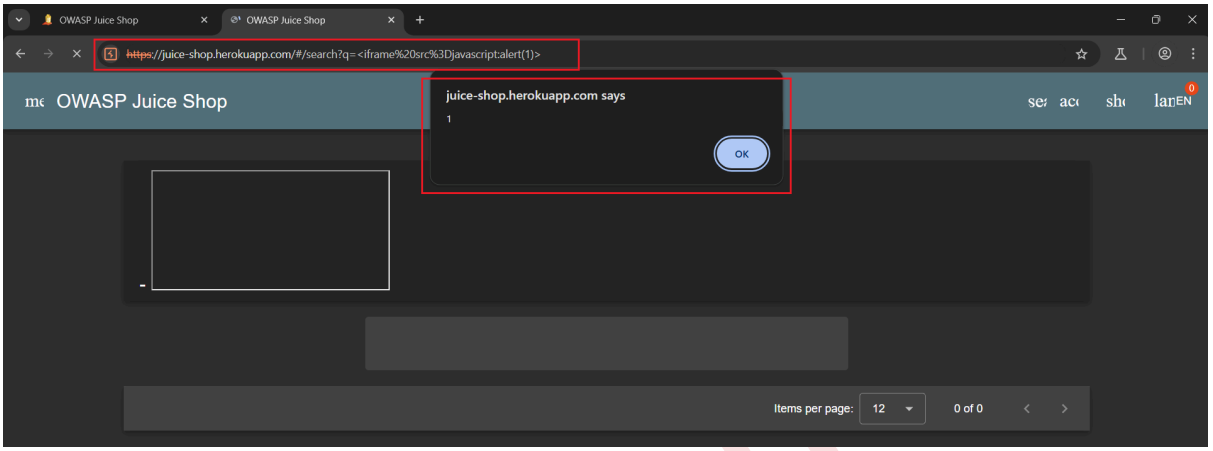
Description: DOM-based XSS occurs entirely inside the browser's Document Object Model (DOM). The application's JavaScript code takes input from a "source" (like `location.hash` or query parameters) and passes it to an unsafe "sink" (like `innerHTML` or `document.write`). In this case, the search functionality reads the URL query and injects it into the page HTML. An attacker can use an iframe payload `<iframe src="javascript:alert(1)">` to trigger execution.

Impact:

- **Identical to Reflected XSS:** Session theft, phishing, and unauthorized actions on behalf of the user.

PoC (Proof of Concept):

- **DOM XSS via Iframe Payload:**



Remediation:

- **Safe Sinks:** Avoid using `innerHTML`; use `textContent` or `innerText` to safely display user input.
- **Input Validation:** Sanitize and validate all data taken from URL or query parameters before inserting into the DOM.
- **Content Security Policy:** Implement a strong CSP to restrict inline scripts and `javascript:` URI execution.

VULN-14: Rate Limiting Failure (Brute Force Susceptibility)

Severity: HIGH

OWASP Category: A07:2025 – Authentication Failures

Affected Component: `/rest/user/login`

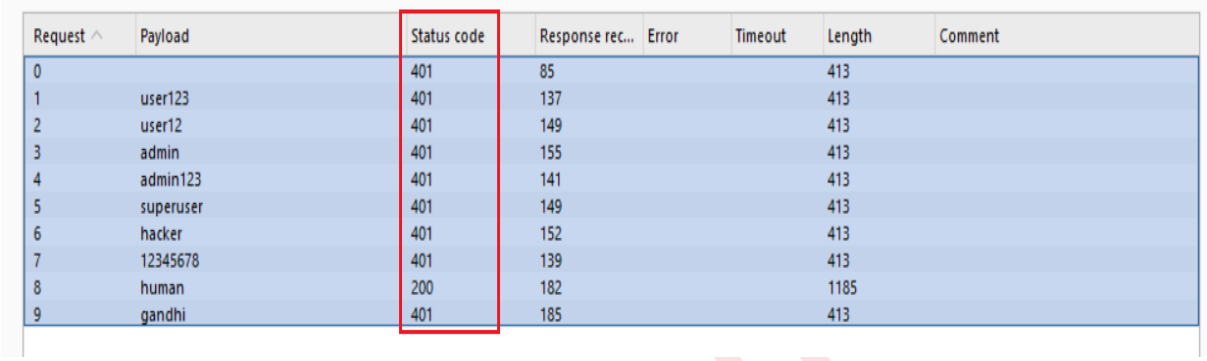
Description: The application does not enforce any limit on the number of failed login attempts from a single IP address or against a single account. This allows an attacker to launch an automated "Brute Force" or "Credential Stuffing" attack, trying thousands of passwords per minute until the correct one is found.

Impact:

- **Account Compromise:** Attackers can easily guess passwords, especially if users reuse passwords from other breaches.
- **Resource Exhaustion:** High-volume login attempts can degrade server performance (DoS).

PoC (Proof of Concept):

- **Burp Intruder Attack (No Blocking Observed):**



Request	Payload	Status code	Response rec...	Error	Timeout	Length	Comment
0		401	85			413	
1	user123	401	137			413	
2	user12	401	149			413	
3	admin	401	155			413	
4	admin123	401	141			413	
5	superuser	401	149			413	
6	hacker	401	152			413	
7	12345678	401	139			413	
8	human	200	182			1185	
9	gandhi	401	185			413	

Remediation:

- **Account Lockout:** Temporarily lock the account after 5-10 failed attempts.
- **IP Throttling:** Implement rate limiting (e.g., max 10 requests per minute).

VULN-15: Weak Password Policy

Severity: HIGH

OWASP Category: A07:2025 – Authentication Failures

Affected Component: User Registration / Password Change

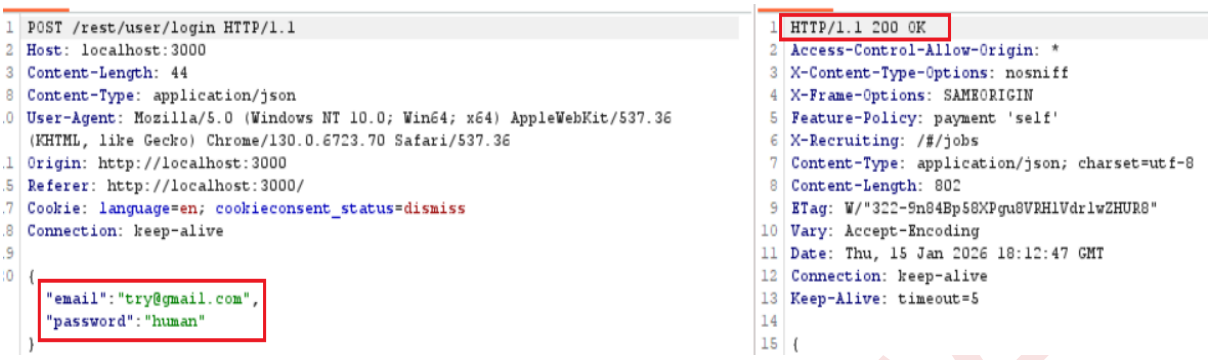
Description: The application allows users to set extremely weak passwords, such as "human", "admin", or "12345". There are no enforcement rules regarding minimum length, complexity (special characters/numbers), or checks against common password lists.

Impact:

- **Weak Security Posture:** Even if rate limiting is enabled, weak passwords can be guessed in very few attempts.

PoC (Proof of Concept):

- **Successful Login with Weak Credentials:**



```
POST /rest/user/login HTTP/1.1
Host: localhost:3000
Content-Length: 44
Content-Type: application/json
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36
(KHTML, like Gecko) Chrome/130.0.6723.70 Safari/537.36
Origin: http://localhost:3000
Referer: http://localhost:3000/
Cookie: language=en; cookieconsent_status=dismiss
Connection: keep-alive

{
  "email":"try@gmail.com",
  "password":"human"
}
```

```
HTTP/1.1 200 OK
Access-Control-Allow-Origin: *
X-Content-Type-Options: nosniff
X-Frame-Options: SAMEORIGIN
Feature-Policy: payment 'self'
X-Recruiting: /#/jobs
Content-Type: application/json; charset=utf-8
Content-Length: 802
ETag: W/"322-9n84Bp58XPgu8VPHlVdrlwZHUR8"
Vary: Accept-Encoding
Date: Thu, 15 Jan 2026 18:12:47 GMT
Connection: keep-alive
Keep-Alive: timeout=5

{
```

Remediation:

- **Enforce Complexity:** Require passwords to be at least 12 characters with uppercase, lowercase, numbers, and special characters.
- **Block Common Passwords:** Reject weak and commonly used passwords using a banned password list.
- **Implement Account Protection:** Combine strong passwords with rate limiting and account lockout after multiple failed attempts.

VULN-16: Client-Side Trust Issues

Severity: HIGH

OWASP Category: A01:2025 – Broken Access Control

Affected Component: Order Processing

Description: The application relies on the client (browser) to calculate and send critical business data, such as the total price of the order or the quantity of items. A malicious user can use a proxy (Burp Suite) to intercept the request and modify these values—for example, changing the price of an item to $0.00 or the quantity to a negative number. The server accepts these values without re-verification.

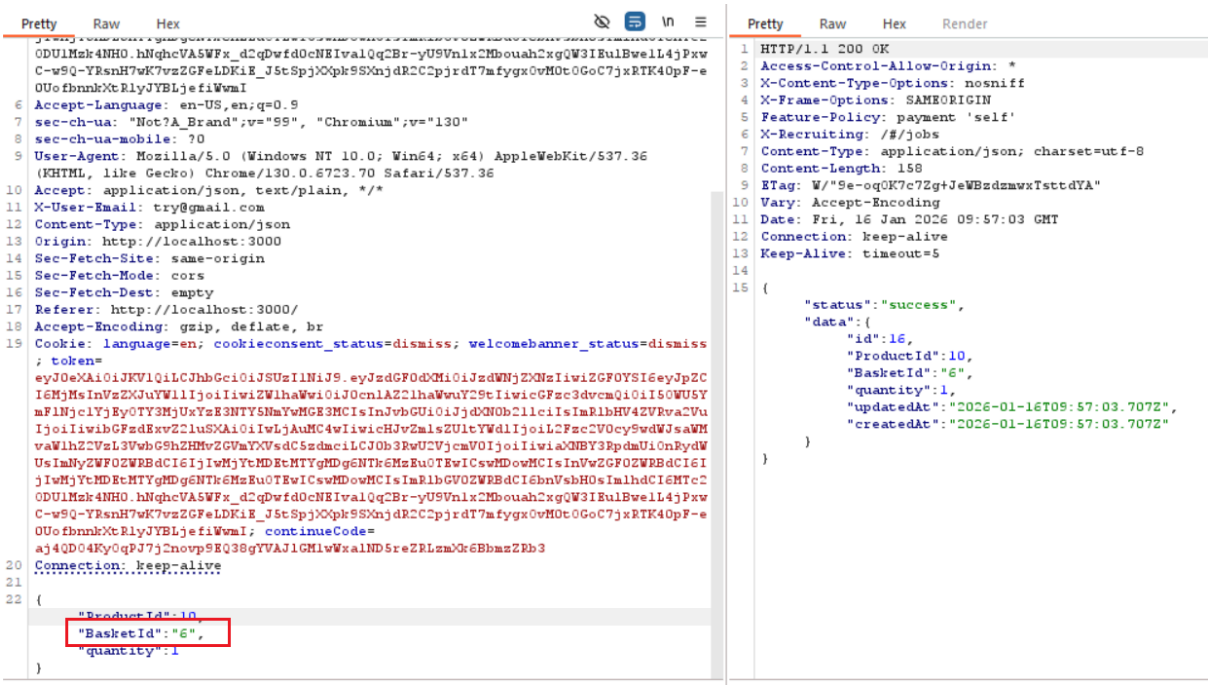
Impact:

- **Financial Loss:** Users can obtain goods for free.

- **Inventory Corruption:** Negative quantities can corrupt inventory databases.

PoC (Proof of Concept):

- **Manipulating IDs and Quantities in Request Body:**



Remediation:

- **Server-Side Logic:** Never trust client calculations. The server must look up the price in the database and calculate the total.

VULN-17: JWT Mismanagement (No Revocation)

Severity: HIGH

OWASP Category: A07:2025 – Authentication Failures

Affected Component: Logout Functionality

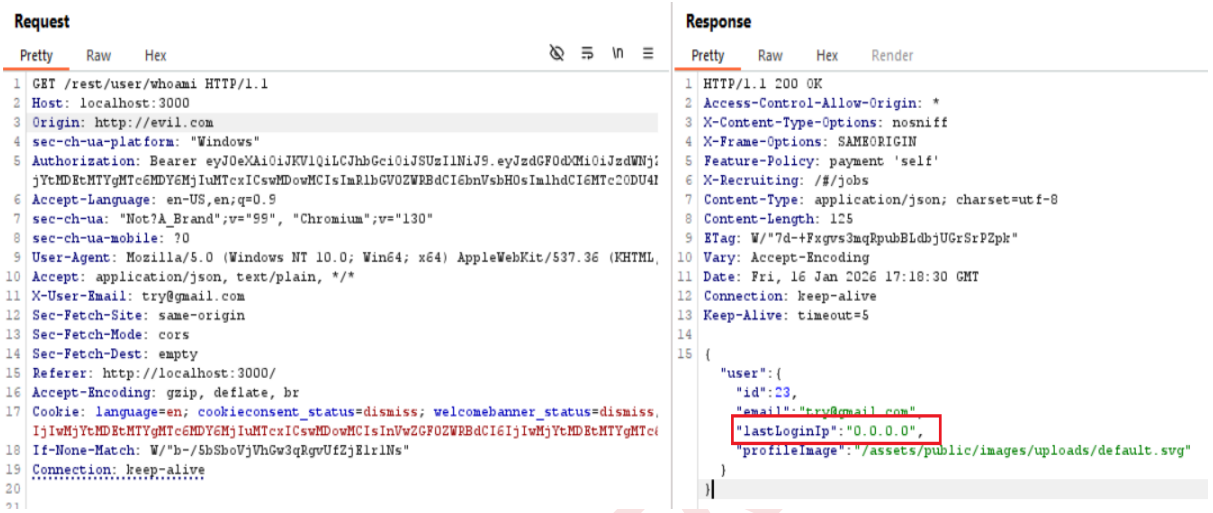
Description: The application does not have a mechanism to invalidate JWTs on the server side. When a user logs out, the application merely deletes the token from the client's browser. However, the token itself remains valid until its natural expiration time. If an attacker has stolen the token, they can continue to use it even after the victim has logged out.

Impact:

- **Persistent Compromise:** Logout provides a false sense of security. Stolen sessions remain active.

PoC (Proof of Concept):

- **Token Remains Valid After Logout (Conceptual - Evidence in Cookie Config):**



Remediation:

- **Token Blocklist:** Maintain a "Blocklist" (e.g., in Redis) of tokens that have been logged out but haven't expired yet.

VULN-18: No Logging of Failed Login Attempts

Severity: HIGH

OWASP Category: A09:2025 – Security Logging and Monitoring Failures

Affected Component: Logging Module

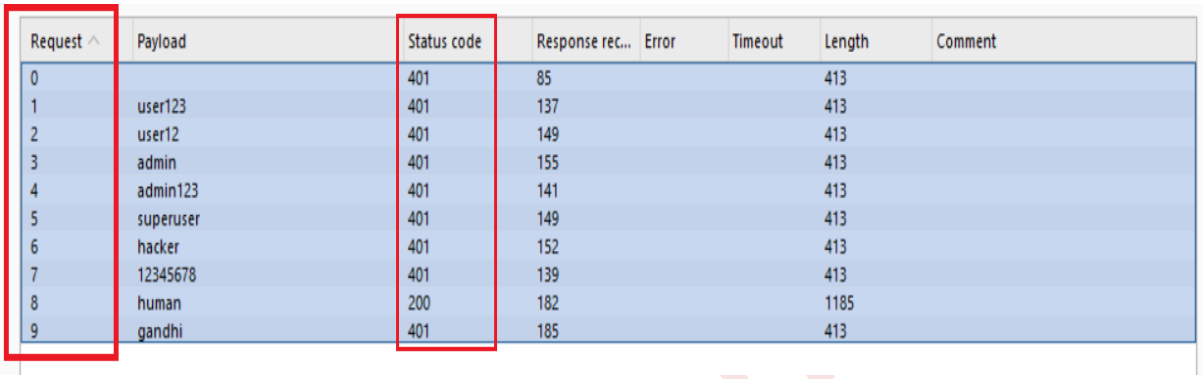
Description: The application fails to generate security logs for critical events, specifically failed authentication attempts. During testing, thousands of `401 Unauthorized` responses were generated, but no alerts or logs were triggered. This "blind spot" allows attackers to probe the system without fear of detection.

Impact:

- **Undetected Breaches:** Attackers can run brute-force attacks for days without the admin noticing.
- **Lack of Forensics:** In the event of a breach, there are no logs to determine how it happened.

PoC (Proof of Concept):

- **High Volume of Failed Requests (No Alerts):**



Request	Payload	Status code	Response rec...	Error	Timeout	Length	Comment
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2	user12	401	149			413	
3	admin	401	155			413	
4	admin123	401	141			413	
5	superuser	401	149			413	
6	hacker	401	152			413	
7	12345678	401	139			413	
8	human	200	182			1185	
9	gandhi	401	185			413	

Remediation:

- **Security Logging:** Log all failed logins, access control failures, and input validation errors.

VULN-19: No Monitoring of Abnormal API Behavior

Severity: HIGH

OWASP Category: A09:2025 – Security Logging and Monitoring Failures

Affected Component: API Gateway

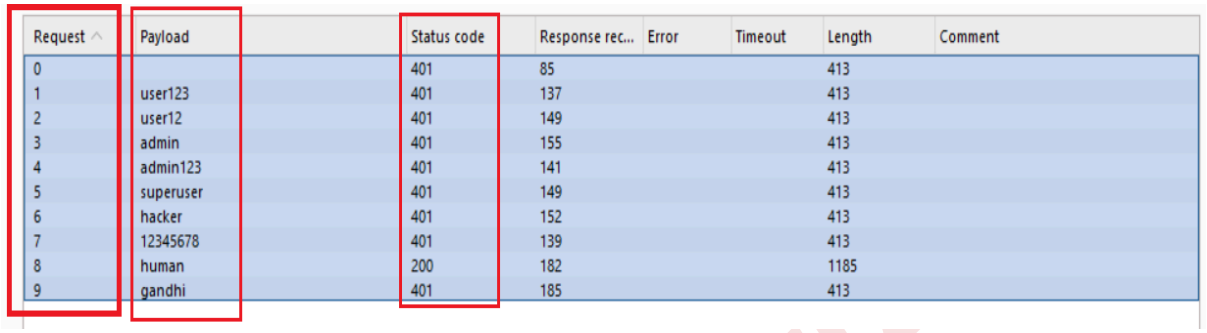
Description: The application lacks behavioral monitoring. During the penetration test, high-velocity fuzzing tools were used to send thousands of malformed requests to the API. A secure system would identify this as an attack pattern (scanning/fuzzing) and block the source IP. Juice Shop continued to serve requests without throttling or blocking.

Impact:

- **Unrestricted Scanning:** Attackers have infinite time and attempts to find hidden vulnerabilities.
- **Resource Drain:** Automated scanners consume server resources, potentially degrading performance for legitimate users.

PoC (Proof of Concept):

- **Sustained Fuzzing Traffic:**



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3	admin	401	155			413	
4	admin123	401	141			413	
5	superuser	401	149			413	
6	hacker	401	152			413	
7	12345678	401	139			413	
8	human	200	182			1185	
9	gandhi	401	185			413	

Remediation:

- **WAF:** Implement a Web Application Firewall (AWS WAF, Cloudflare) to detect and block scanning tools.

VULN-20: Cross-Site Request Forgery (CSRF)

Severity: HIGH

OWASP Category: A01:2025 – Broken Access Control

Affected Component: Login / Password Change

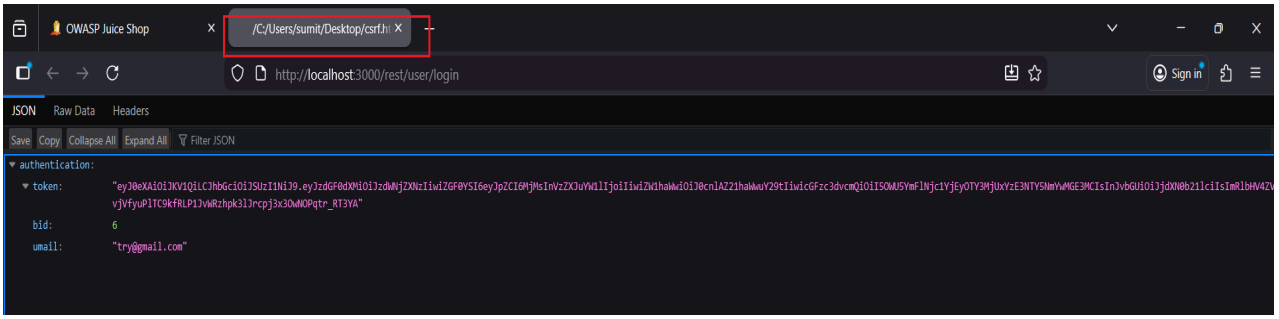
Description: CSRF allows an attacker to ride on the active session of a victim. Because the Juice Shop API relies on cookies for authentication but does not enforce Anti-CSRF tokens or `SameSite` cookie attributes, a malicious site can send a `POST` request to `https://juice-shop.herokuapp.com/rest/user/password-change`. If the victim visits the malicious site while logged in, the browser sends the request *with* the victim's cookies, changing their password without their consent.

Impact:

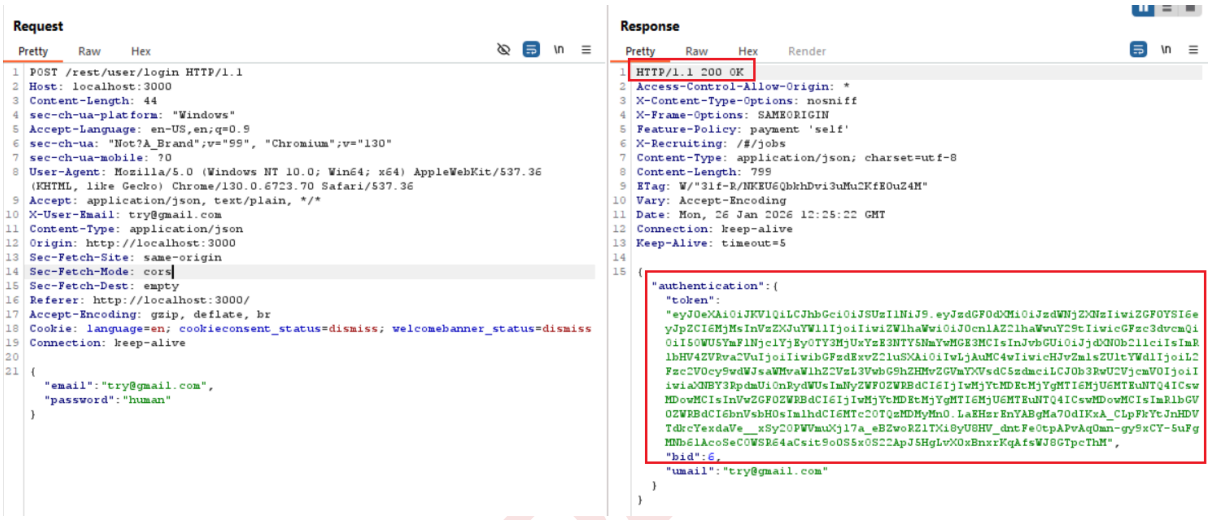
- **Account Takeover:** Attackers can change the victim's email or password.
- **Unauthorized Actions:** Attackers can make purchases or post reviews as the victim.

PoC (Proof of Concept):

- **CSRF PoC Request (External Origin):**



- **Successful Execution Response:**



Remediation:

- **SameSite Cookies:** Set the `SameSite` attribute on session cookies to `Strict` or `Lax`.
- **Anti-CSRF Tokens:** Require a random, unpredictable token (e.g., `X-CSRF-Token`) in the headers of all state-changing requests.

6.3 Medium Severity Findings

VULN-21: Verbose Error Messages Disclosure

Severity: MEDIUM

OWASP Category: A10:2025 – Mishandling of Exceptional Conditions

Affected Component: Global Error Handling

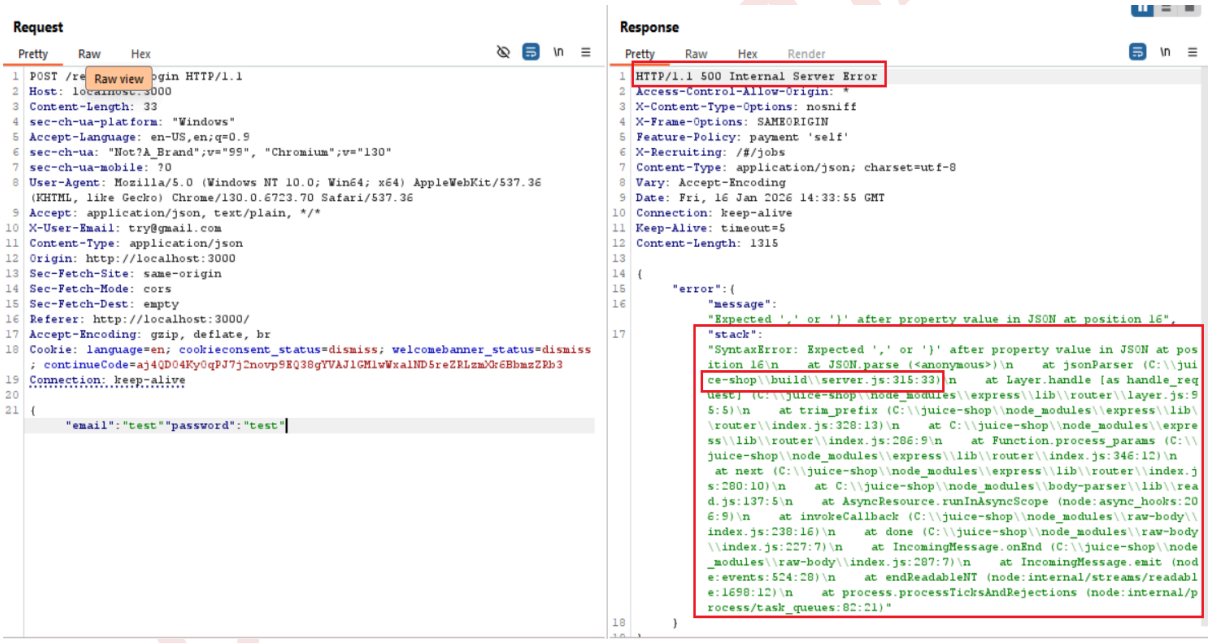
Description: The application is running in a debug or development mode. When an input error occurs (e.g., malformed JSON or SQL syntax error), the server returns a detailed stack trace, internal file paths (e.g., `/app/routes/index.js`), and specific database error messages (e.g., `SequelizeUniqueConstraintError`). This violates the security principle of "Security by Obscurity" regarding internal architecture.

Impact:

- **Information Disclosure:** Reveals the technology stack (Express, Sequelize, SQLite) and internal directory structure.
- **Exploitation Aid:** Helps attackers craft precise SQL injection payloads by revealing the exact syntax errors generated by the database.

PoC (Proof of Concept):

- **Stack Trace & File Paths:**



Remediation:

- **Disable Debug Mode:** Ensure the application is running with `NODE_ENV=production`.
- **Generic Error Pages:** Catch all exceptions globally and return a generic `500 Internal Server Error` message to the user (e.g., "Something went wrong").
- **Server-Side Logging:** Log the detailed stack traces to a secure, internal logging system (like ELK or Splunk) instead of sending them to the client.

VULN-22: Missing Security Headers

Severity: MEDIUM

OWASP Category: A02:2025 – Security Misconfiguration

Affected Component: HTTP Responses

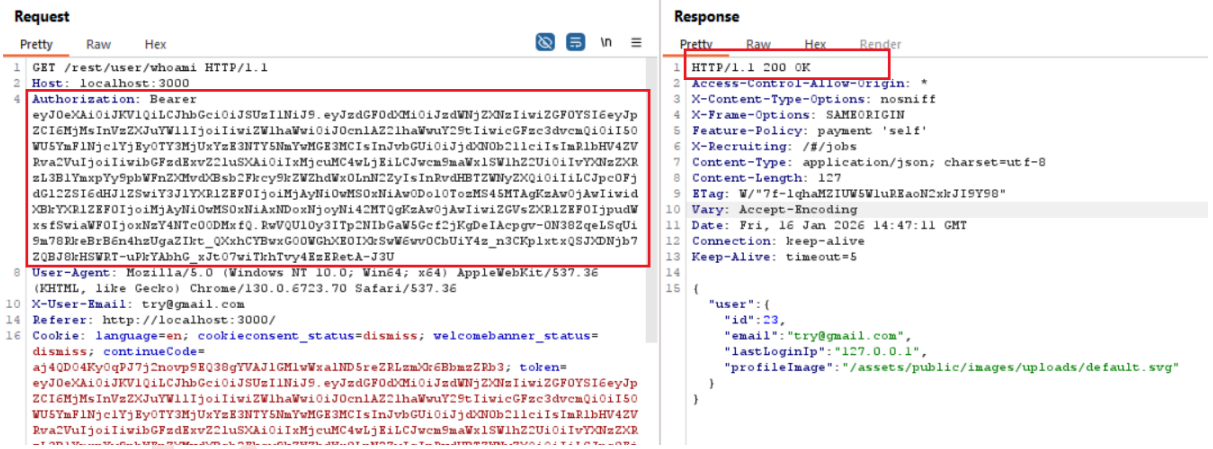
Description: The application fails to set standard HTTP security headers that protect users from common browser-based attacks. Specifically, headers such as `Strict-Transport-Security` (HSTS), `Content-Security-Policy` (CSP), `X-Frame-Options`, and `X-Content-Type-Options` are missing.

Impact:

- **Clickjacking:** Lack of `X-Frame-Options` allows the site to be framed by malicious sites.
- **XSS:** Lack of `CSP` makes it easier to execute malicious scripts.

PoC (Proof of Concept):

- **Headers Analysis:**



Remediation:

- **Implement HSTS:** `Strict-Transport-Security: max-age=31536000; includeSubDomains`
- **Implement CSP:** `Content-Security-Policy: default-src 'self'`

VULN-23: Improper Exception Handling

Severity: MEDIUM

OWASP Category: A10:2025 – Mishandling of Exceptional Conditions

Affected Component: Global

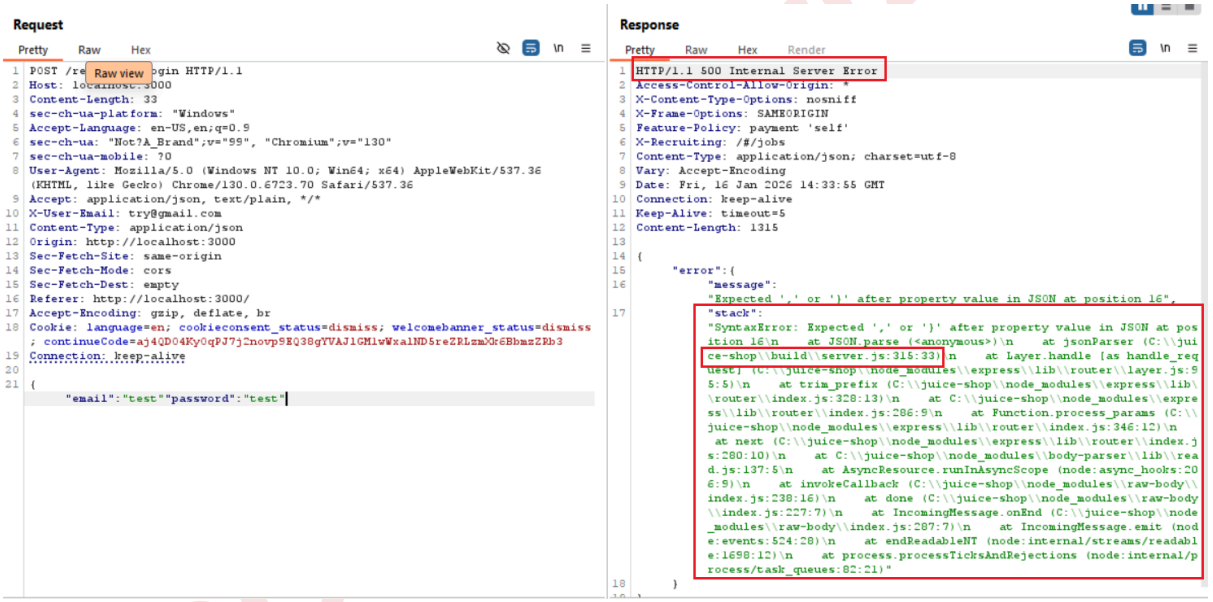
Description: The application does not use global `try/catch` blocks or a centralized error handling middleware effectively. When malicious input causes a crash (e.g., passing a string where an int is expected), the server throws an unhandled exception and crashes or returns an HTTP 500 status with an HTML stack trace.

Impact:

- **Denial of Service (DoS):** Repeatedly crashing the server can take the application offline for all users.
- **Attack Surface:** Unhandled exceptions often leave the application in an undefined state.

PoC (Proof of Concept):

- **500 Internal Server Error Response:**



Remediation:

- **Global Error Handler:** Implement a middleware in Express to catch all errors.
- **Graceful Degradation:** Ensure the application returns a generic error message and continues running.

VULN-24: Information Leakage Through Error Responses

Severity: MEDIUM

OWASP Category: A10:2025 – Mishandling of Exceptional Conditions

Affected Component: API Error Responses

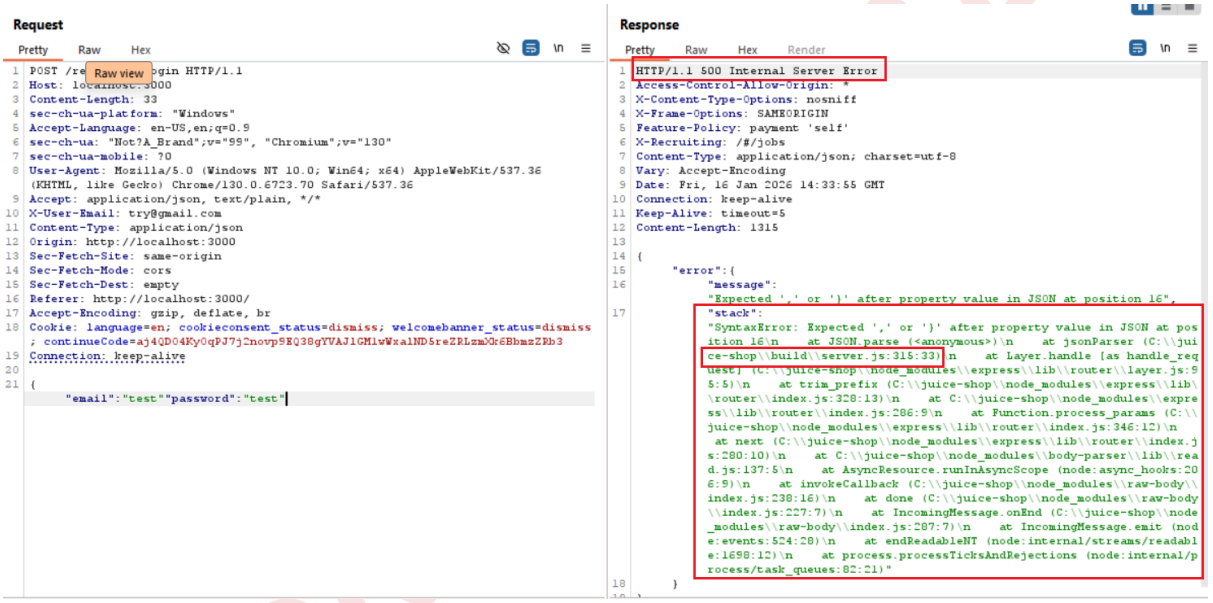
Description: This is specific to the *content* of the errors. The API responses include internal details such as database table names, column names, and SQL logic errors. This confirms to an attacker that they have successfully hit the database and provides a roadmap for constructing a working SQL Injection payload.

Impact:

- **Accelerated Exploitation:** Reduces the time and effort required for an attacker to develop a working exploit.

PoC (Proof of Concept):

- **Leaked Internal Paths and Logic:**



Remediation:

- **Sanitize Error Responses:** Return generic error messages to users and avoid exposing stack traces, SQL queries, or internal paths.

- **Centralized Error Handling:** Implement global exception handling middleware to catch and properly format all errors.

- **Secure Server Logging:** Log detailed errors only on the server side for debugging while keeping client responses minimal.

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7. Conclusion & Strategic Roadmap

The security assessment of OWASP Juice Shop revealed an overall **Critical risk level**. The identified vulnerabilities indicate weaknesses in access control, authentication, input validation, and monitoring mechanisms. If left unaddressed, these issues could allow attackers to compromise user accounts, access sensitive data, and perform unauthorized actions.

A phased remediation strategy is recommended to reduce risk effectively.

Immediate Priorities (0–30 Days) — Stop the Bleeding

- **Fix Injection & Access Control:** Remediate SQL Injection (VULN-01) and IDOR (VULN-06) using parameterized queries and strict ownership checks.
- **Strengthen Authentication:** Implement rate limiting (VULN-14) and enforce strong password policy (VULN-15).
- **Prevent XSS:** Sanitize user input and replace unsafe DOM methods to mitigate Reflected and DOM XSS (VULN-12, VULN-13).

Goal: Block the most easily exploitable attack paths.

Strategic Goals (1–3 Months)

- **Access Control Redesign:** Enforce server-side authorization on every API request and apply RBAC consistently.
- **Adopt DevSecOps:** Integrate npm audit and security scanning into CI/CD to manage vulnerable dependencies (VULN-08).
- **Improve Monitoring:** Implement centralized logging, alerting, and optionally a WAF to detect attacks (VULN-18, VULN-19).

Goal: Build long-term security resilience.

Final Assessment

OWASP Juice Shop demonstrates how multiple small weaknesses can combine into a **high-risk security posture**. By prioritizing critical fixes and adopting secure development practices, the application can significantly reduce its attack surface and improve overall security maturity.

Overall Risk Rating: CRITICAL