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Section 1.
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APPLICATION OF EXPERT ASSESSMENT OF VULNERABILITIES IN ENTERPRISE DATA

Abstract. The article focuses on the current goals of research in the field of cybersecurity. The decision-making system used and examples of classification of expert assessments are given. The assessment of the relevance of the knowledge base for machine learning algorithms is determined. Examples of building diagnostic images to identify vulnerability incidents are given. The necessity of establishing the data structure of diagnostic information is revealed.

Keywords: data mining, expert systems, machine learning, security, diagnostic rules, knowledge base, datasets.

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ПРИМЕНЕНИЕ ЭКСПЕРТНОЙ ОЦЕНКИ УЯЗВИМОСТЕЙ В ДАННЫХ НА ПРЕДПРИЯТИИ

Аннотация. В статье внимание обращено на актуальные цели исследования в области кибербезопасности. Приведена используемая система принятия решений и примеры классификации экспертных оценок. Определена оценка востребованности базы знаний для алгоритмов машинного обучения. Приведены примеры построения диагностических образов для выявления инцидентов уязвимостей. Выявлена необходимость установления структуры данных диагностической информации.

Ключевые слова: интеллектуальный анализ данных, экспертные системы, машинное обучение, безопасность, диагностические правила, база знаний, датасеты.

Введение

Каждое предприятие работает с данными, которые требуют повышенного контроля. Из-за уязвимостей, на предприятиях повышается степень угрозы скрытых атак на данные, следовательно, свою работоспособность теряют все структуры отделов. Применение экспертной системы как аналитико-прогностического метода позволит предотвратить утечку данных, благодаря интеллектуальному анализу диагностической информации.

Аналитическая обработка данных предполагает интеллектуальный разбор метрик с применением алгоритмов машинного обучения. Требуется создание экспертной системы, чтобы осуществить качественный анализа диагностической информации [1]. База знаний формируется из аномалий обнаруженных при сканировании скрытых угроз с применением оценки узкопрофильного специалиста в области кибербезопасности и управления информационными системами. Исследование диагностической информации уязвимостей можно начать с рассмотрения распространенных источников таких как Kaggle, Data world, Datasetsearch и т.д. Датасеты являются источниками знаний и правил.

Выбор набора данных зависит от цели применения разрабатываемой системы. Также стоит учесть признаки, которые зависят от специфики узкопрофильного эксперта в области обнаружения инцидентов кибербезопасности.

Постановка задачи

Создание единой базы знаний для структурирования признаков скрытых атак и их описаний в информационных системах предприятий является главным критерием повышения точности модели машинного обучения. Первая и наиболее важная задача – это осуществление подбора критериев внешних состояний. Следовательно, разработка и внедрение информационного образа и системы представления знаний в информационные системы обеспечения безопасности данных на предприятиях. Для этого следует организовать процедуру получения качественных параметров при реализации ИО. Степень устойчивости алгоритма к наличию в данных аномальных значений будет являться робастностью системы, что благотворно влияет на достоверность модели машинного обучения и предполагает до 98,9% качества. При построении структуры модели машинного обучения все внимание отдают показателю качества выполнения алгоритма. Если при выполнении задачи функция имеет значение ниже 95%, то система обработки данных идет на модернизацию алгоритма [2]. Построение пайплайна потребует достаточно много времени из-за большого количества данных и их обработки.

Целью создания пайплайна представляет собой разработку многофункциональной системы управления безопасностью данных на предприятии. Определение новых параметров и критериев отбора при анализе датасетов позволит конкретизировать объект исследования. Для дальнейшего развития системы поиска нужно определить место в организации корпорации. Учет всех факторов индивидуальных состояний структур предприятий обуславливает качественную защиту данных и внутренних процессов. Исследование данного вопроса позволит без потерь внедрять систему поиска уязвимостей. Качественный анализ данных завершит глубокое обучение на стадии поиска оптимального алгоритма [3].

Решение проблемы

Чтобы систематизировать диагностические правила для базы знаний потребуется введение новых значений уязвимостей и привлечение экспертной оценки. Для этого все внимание будет нацелено на исследование датасетов и ПО идентификации атак, показано в таблице 1. Приведение новых параметров к единому стандарту записи и усовершенствование правил, введение новых алгоритмов и аналитико-прогностических систем позволит качественно и быстро осуществить внедрение в структуры предприятия для обнаружения скрытых атак. Для определенных параметров выделим информативные критерии и информативные диапазоны критерий. Найденные значения примут вид качественных показателей, как показано в таблице 1.

Таблица 1.– Пример динамических диагностических правил

№	P_0	P_1	P_2	P_3	Оценка	Вероятность оценки	Примечания
1	11:20	+	++	+	Уменьшение производительности	0,91	задача 1
2	12:55	++	++	++	Изменения в диагностических данных	0,98	задача 2
3	14:20	++	++	+	Увеличение производительности	0,95	задача 3
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
m					n		L

Пример экспертной модели демонстрирует наличие 3 задач, где оценивается состав уязвимости, время появление и вероятность определения. В зависимости от задачи присутствуют следующие показатели: уменьшение производительности, изменения в диагностических данных, увеличение производительности. Для создания полных и неполных информационных образов каждого узла уязвимости, применяется техника составление диагностических правил с использованием разностороннего определения сочетаний.

Актуальность создания новых методов и алгоритмов решения задач обнаружения угроз подтверждается растущим количеством данных в промышленности, требующей постоянной диагностики скрытых уязвимостей. Применение методов искусственного интеллекта в связке с аналитико – прогностической системой для реорганизации данных в знания – это перспектива многофункциональной системы обработки диагностической информации объекта исследования. Следовательно, необходимо осуществить классификацию структуры данных и применить конструкцию данных: пространственных (cross section data), панельных (panel data) или временных рядов (time series). Также при внедрении системы защиты и идентификации уязвимостей на предприятии стоит учесть риски внутренних обвалов в системах [4]. Для этого будет сконцентрировано внимание на круглосуточный мониторинге и анализе обнаруженных признаков.

Так как, диагностическая информация имеет изменчивый характер, весьма действенен метод регрессионного анализа, что приведет к определению новых зависимостей и состояний. Это уменьшит ошибки в последующей обработке модели алгоритмами машинного обучения. Чтобы увеличить производительность системы поиска требуется применить параллельно обучение.

Заключение

Рассмотрение вопроса защищенности данных на предприятии показало уязвимости, которые трудно обнаружить и без точечного анализа не обойтись. Это угрозы сформированные нейронной сеть и алгоритмами машинного обучения. Также применение методов искусственного интеллекта злоумышленниками позволяет им долгое время быть необнаруженными в структурах предприятия.

Для точечного анализа уязвимостей в системе определения инцидентов кибербезопасности требуется параллельное применение методов и алгоритмов искусственного интеллекта. Построенная модель ориентированных диагностических правил для составления экспертной оценки, будет применена в модели машинного обучения, как ветвь анализа идентифицируемых признаков. Чтобы реализовать качественную метрику данных потребуется использовать знания узкопрофильного специалиста. Специалист должен иметь опыт устранения точечных инцидентов на предприятиях. Быстрое внедрение экспертной системы – будет возможно при наличии ее в составной части информационной системы. Также использование инновационной модели поиска сбалансирует производительность предприятия и уменьшит потерю данных.

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Section 2.
Technical sciences

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COMBINED CARGO SERVICE AS A VARIANT OF LOGISTICS DEVELOPMENT IN A CRISIS PERIOD

The relevance of the organization of the combined cargo service is due to the need for cargo delivery by logistics companies in the conditions of the crisis caused by the COVID-19 pandemic. The restoration of the volume of transport services after the crisis associated with restrictive measures due to the COVID-19 pandemic began already in the second half of 2020, currently suspended production is resuming work, delivery of raw materials, components, finished products is required, demand for transportation is growing. It takes time to restore production and transportation volumes to the level of the pre-covid period, now companies are forced to look for opportunities to reduce costs. One of the savings options was the return to the organization of transportation of combined cargoes.

Combined transportation means the transportation of small-sized cargoes of various customers in one direction on one vehicle. Most often these are small transport units that do not exceed the dimensions of one Euro pallet and weighing no more than 350 kilograms. In railway transport, a consignment that does not require the provision of a separate wagon or container and is presented on a single railway bill of lading is called a small shipment. The abbreviations LTL and LCL are used in the logistics of international and multimodal transport. LTL or "Less than Truck Load", literally means "partially loaded truck", the cargo of several customers is transported by road, transportation costs are divided among all customers of the service. LCL or "Less than Container Load" is a partially loaded container, consolidated transportation of several cargoes in one container [4].

Logistics companies organize transportation of combined cargoes:

- consolidate shipments of different customers at their terminal to an economically justified volume of transportation (goods are weighed. are measured, marked, if necessary, additionally packed);
- provide services for the delivery of small-volume shipments over long distances, reducing the possible transport costs of individual shippers: when delivering bulk cargo, the cost is distributed among the senders according to the occupied area and the established tariffs [3];
- arrange delivery to the terminal at the destination using all convenient modes of transport, including multimodal transportation;
- the transport batch is disbanded and the cargo is delivered to the recipients (or the consignee can pick it up independently from the warehouse).

The attractiveness of this delivery option is explained by the requirements of the market during the crisis: the goods must be delivered on time, small and medium-sized companies do not have the opportunity to accumulate cargo up to the volume of a container (or a whole car), risking losing customers due to long delivery.

Competition with unstable demand is intensifying, the struggle for the customer forces companies to apply new work technologies and use already known ones, such as the transportation of bulk cargoes. One of the ways to reduce costs is to abandon the stocks of products, from the costs of their storage, while raw materials, components or finished products are sent in small batches.

We will highlight the main advantages of the combined cargo service:

- cheaper delivery method (smaller batch, transportation of bulk cargo is cheaper than renting a separate container or a car;
- regular dispatch schedule;
- the possibility of redirecting cargo in transit;
- logistics company solves all transportation issues.

The disadvantages of transportation of combined cargoes include:

- unsecured cargo in terms of quantity and quality due to damage during loading and unloading operations, warehousing, as well as due to the presence of a human factor;
- longer delivery, due to a certain schedule of transportation of combined cargo and the organization of transportation.

Risks in the organization of transportation of combined cargoes, in addition to cargo damage, include violation of delivery times due to additional customs control measures during import, special requirements for the transportation of dangerous and excise goods [5]. The use of containers allows to ensure the safety of combined cargoes en route and during transshipment, to avoid additional costs for transshipment operations and to optimize their duration in multimodal delivery schemes.

The cost of delivery of the combined cargo depends on the distance and complexity of the route, the characteristics of the cargo (weight, size), the need to pack the cargo, the provision of additional services. The break-even point for the customer when sending a combined service is the volume of transportation of 19 cubic meters, i.e. the cost of sending which is comparable to the cost of sending one 20-foot container with a cargo volume of 35 cubic meters [2].

The most frequently used transport for organizing the transportation of bulk cargo is automobile, the most accessible (including for remote settlements), which allows you to organize door-to-door delivery (logisticians determine the optimal route with stops at specified points or at the warehouse of the carrier company), which minimizes the risks of losses in the quantity and quality of goods [3]. Rail delivery is a popular logistics service, but it requires more time to organize transportation, initial and final operations at loading and unloading points, therefore it is effective over long distances. Air transport is very fast delivery but expensive, in addition there are restrictions on the dimensions of the cargo, it is used for courier express delivery of small by weight cargo. Sea transportation is relevant in international transportation and for the supply of hard-to-reach areas. River transport directly depends on navigation, is used for large shipments, delivery is relatively cheap, but long. For small and medium-sized businesses, the balance between cost and speed of delivery is important, which is better provided by road transport than others [6].

Among the factors of growth in demand for the combined cargo service are the development of online commerce and the territorial expansion of retail chains [5]. There is a particularly high demand now for combined cargoes from European countries, e-commerce goods come out on top. Unlike standard imported goods, they are small in size.

E-commerce is the process of buying and selling products using electronic means, such as mobile applications and the Internet. E-commerce enterprises have significantly lower operating costs compared to physical stores: no rent, no staff, operating costs are lower compared to traditional retail enterprises. E-commerce stores have expanded significantly during the pandemic, thanks to the possibility of remote orders and contactless delivery, continuous operation during lockdowns [7].

During the pandemic, many logistics companies were forced to start optimizing their activities, respond to changes in market demand, introduce IT technologies that allow them to interact more effectively with supply chain participants, and switch to electronic document management. Cargo tracking online, online ordering, transportation calculation become basic services.

Combined transportation allows shippers to get well-established and efficient logistics at a reasonable price. Combined cargoes allow the logistics market to develop, even in a crisis, they allow you to quickly organize the delivery of any amount of cargo but the most economical and efficient is the transportation of small and medium-sized batches[1]. The optimal cost of transportation is an important advantage of the combined cargo service, especially relevant during the crisis and the search by entrepreneurs for ways to reduce costs.

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QUALITY AND SAFETY STUDY OF A NEW MAYONNAISE SAUCE

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ИССЛЕДОВАНИЕ КАЧЕСТВА И БЕЗОПАСНОСТИ НОВОГО МАЙОНЕЗНОГО СОУСА

Сегодня общественные знания о диете и здоровье расширились, заставляя людей потреблять продукты питания с функциональными особенностями. Таким образом, потребители, осознающие значительное влияние диеты на их здоровье, требуют более питательной и здоровой пищи.

Каждый ингредиент играет определенную роль в текстурной стабильности, а использование альтернативных эмульгаторов и заменителей жира может повлиять на сенсорные, текстурные и антиоксидантные свойства майонеза. Помимо заменителей жира, майонез сопровождается биологически активными ингредиентами для поддержания здоровья организма [1].

Разработка новых продуктов питания становится все более сложной задачей, поскольку она должна соответствовать требованиям потребителей, особенно в отношении продуктов питания для здорового питания. В этой связи большое значение имеют функциональные продукты питания, которые полезны для здоровья в дополнение к питательному содержанию, и особенно продукты с пониженным содержанием жира [2].

Основные аспекты формирования функциональных свойств майонезов предусматривает решение задач, к которым относятся уменьшение калорийности за счет снижения массовой доли растительных масел, создание стабильных низкожирных майонезов с хорошими органолептическими свойствами; улучшение жирнокислотного состава жировой фазы путем использования в рецептурных составах купажированных растительных масел; снижение содержания в рецептурах или полное исключение из составов майонезов холестеринсодержащего сырья путем повышения эмульгирующей способности яичных продуктов или их замены на растительные фосфолипиды или другие поверхностно-активные вещества; обогащение майонезов не только жирорастворимыми (A, D, E, в-каротином), но и водорастворимыми витаминами, а также пищевыми волокнами, в том числе – с пребиотическими свойствами; увеличение сроков хранения, предотвращение микробиологической, гидролитической и окислительной порчи майонезов путем использования добавок натурального происхождения с высокой антиоксидантной активностью – токоферолов, растительных экстрактов [3].

В настоящее время потребление функциональных продуктов питания распространилось по всему миру и поощряется растущим диетическим интересом потребителей. Потребители желают покупать функциональные продукты питания, в которых они признают полезные для здоровья свойства, отсутствующие в обычных продуктах питания [4].

С этой целью в майонезный соус был добавлен полезный ингредиент – гидролизат коллагена.

Одним из свойств коллагенового гидролизата является его эмульгирующая способност [5], что соответственно влияет на сроки хранения майонеза.

Таким образом, целью данной работы является разработка рецептуры функционального майонезного соуса с добавлением коллагенового гидролизата и изучение свойств данного продукта.

Результаты исследования показали, что применение коллагена в кисломолочных продуктах позволяет организму человека быстрее и лучше усваивать коллагеновые пептиды [6].

Такие изделия обладают и другими свойствами, привлекательными для потребителей.

Гидролизованный коллаген благотворно влияет на некоторые пробиотические культуры, традиционно используемые в молочных продуктах [7].

То есть майонезный соус с коллагеном является эффективной формой использования гидролизованного коллагена в качестве профилактического средства по сравнению с другими формами [8].

Исследования показывают, что при производстве функционального майонезного соуса используется добавление в майонез некоторых функциональных ингредиентов [9].

Исследования проводили в лаборатории Казахского национального аграрного исследовательского университета (Каз-

НАИУ) на кафедре «Технология и безопасность пищевых производств», в Казахстанско-японском центре при КазНАИУ, в лабораториях ТОО «Еркин Талгам».

Объектами исследований является майонезный соус с добавлением коллагенового гидролизата на основе: подсолнечного и смеси масел со сбалансированным жирнокислотным составом.

В ходе исследований в образцах майонезного соуса с добавлением коллагенового гидролизата на основе смесей растительных масел со сбалансированным жирно-кислотным составом определены микробиологические и показатели безопасности майонезного соуса.

Определение микробиологических показателей: количество: дрожжей и плесневых грибов по ГОСТ 10444.12–88; бактерий группы кишечной палочки – ГОСТ 31747–2012; патогенных, в том числе сальмонеллы,– ГОСТ 31659–2012.

Приготовление майонезного соуса проводили ниже описанным способом. Воду, соль, сахар, пищевые добавки предварительно перемешивали до образования однородного раствора и нагревали до 80–85 °С, с последующем выдерживанием в течение 10 минут и охлаждением до 60 °С. После чего добавили яичный продукт. Образовавшийся раствор выдерживали при температуре 60–65 °С в течение 3 минут. Далее в полученный раствор медленно добавляли частями смеси растительного масла с одновременным перемешиванием. После перемешивания в продукт вносили уксусную кислоту, предварительно разведенную в рецептурной воде в соотношении 1:8. Затем продукт перемешивали и проводили его гомогенизацию.

В 1 литр растительного масла можно добавить 42 грамма гидролизата коллагена. В нашем случае с целью получения майонезного соуса разработана рецептура с содержанием в 250 граммах растительного масла 10,5 грамма гидролизата коллагена.

Учитывая пользу гидролизата коллагена для организма человека, при составлении рецептуры следили за тем, чтобы его изготавливали, смешивая в растворенном виде в равных частях растительных масел.

В работе используется пептиды гидролизата коллагена в качестве функционального ингредиента для расширения ассортимента майонезных соусов.

Суточная потребность человека в коллагене легко покрывается употреблением только одной порции майонеза, содержащей 2–3 г гидролизованного коллагена. При этом потребитель получает не только пользу, но и наслаждается вкусом продукта.

Введение коллагена в рецептуру не требует дополнительного оборудования или изменения технологического процесса.

Коллаген полностью растворяется в растительном масле, у него нет температурных или механических ограничений. Это свойство является одним из наиболее важных и расширяет преимущество использования гидролизованного коллагена в майонезных соусах.

Состав майонезного соуса с сбалансированным составом растительных масел с добавлением коллагенового гидролизата.

В качестве объектов исследования были изучены три образца: в качестве контрольного образца был использован продукт из подсолнечного масла.

В дальнейшем этот образец смеси послужил основой для получения образцов майонезного соуса.

Концентрации тяжелых металлов, пестицидов, а также микотоксинов в майонезе и майонезном соусе анализировались в соответствии с ТР ТС 021/2011 технического регламента Таможенного союза «О безопасности пищевой продукции».

Содержание тяжелых металлов, пестицидов и микотоксинов в опытных образцах представлены в таблице 1.

Таблица 1.– Определение показателей безопасности майонезных соусов

Наименование показателя	**Норматив-ное значение по ГОСТ**	**Контроль-ный об-разец**	**Опытный образец майонезного соуса**	
			№ 1	**№ 2**
Токсичные элементы:				
Свинец, мг/кг,	не более 0,3	0,23	0,23	0,1
Кадмий, мг/кг,	не более 0,05	не обнару-жено	не обнару-жено	не обнару-жено
Мышьяк, мг/кг,	не более 0,1	не обнару-жено	не обнару-жено	не обнару-жено
Ртуть, мг/кг,	не более 0,05	не обнару-жено	не обнару-жено	не обнару-жено
Пестициды:				
ГХЦГ (α, β, γ-изомеры), мг/кг,	не более 0,2	не обнару-жено	не обнару-жено	не обнару-жено
ДДТ и его мета-болиты, мг/кг, не более	0,2	не обнару-жено	не обнару-жено	не обнару-жено
Микотоксины:				
Афлотоксин B_1, мг/кг,	не более 0,005	не обнару-жено	не обнару-жено	не обнару-жено

Результаты анализа образцов майонезного соуса показали, что максимальное загрязнение свинца (Pb) в образце № 2 и составило 0,1 мг/кг, что не превышает нормативного значения.

Содержание кадмия (Cd), ионов мышьяка (As) и ртути (Hg), пестицидов (ГХЦГ (α, β, γ-изомеры), (ДДТ и его метаболиты) и микотоксина (Афлотоксин B1) в опытных образцах не обнаружено.

Полученные результаты значения тяжелых металлов, пестицидов и микотоксинов в опытных образцах не превышали установленные нормативными документами предельно допустимые концентрации (ПДК).

Микробиологические показатели, которые установленны Техническим регламентом на масложировую продукцию ТР ТС 024/2011 представлены в таблице 2.

Таблица 2. – Микробиологические показатели майонезных соусов

Наименование показателя		Нормативное значение по ГОСТ	Контрольный образец	Опытный образец майонезного соуса	
				№ 1	№ 2
Масса продукта (г) в который не допускается	БГКП (колиформы)	0,1	не обнаружено	не обнаружено	не обнаружено
	Патогенные, в т.ч. сальмонеллы	25	не обнаружено	не обнаружено	не обнаружено
Дрожжи, КОЕ/г^2, не более		5×10^2	$<1{,}0 \times 10^1$	$<1{,}0 \times 10^1$	$<1{,}0 \times 10^8$
Плесени, КОЕ/г, не более		50	$<5{,}0 \times 10^1$	$<5{,}0 \times 10^1$	$<5{,}0 \times 10^8$

Исследование нового образца майонезного соуса соответствует всем критериям нормативного документа и дополняют ассортимент масложировой продукции.

Исходя из полученных данных видно, что майонезный соус с добавлением коллагенового гидролизата на основе смеси масел со сбалансированным жирнокислотным составом показал наилучший результат по сравнению с образцом на основе подсолнечного масла – контрольный образец.

В исследовании показателей безопасности майонезных соусов максимальное загрязнение свинца (Pb) при 80:15:05 составило 0,1 мг/кг, Содержание кадмия (Cd), ионов мышьяка (As) и ртути (Hg), пестицидов (ГХЦГ (α, β, γ-изомеры),(ДДТ и его метаболиты) и микотоксина (Афлотоксин B_1) в образцах не обнаружено.

Показателем качества продукции, которая является микробиологическая безопасность, соответсвоует нормам, установленным ТР ТС 024/2011.

Учитывая вышеизложенное, необходимо отметить, что новая рецептура майонезного соуса с добавлением коллагенового гидролизата на основе смеси масел со сбалансированным жирнокислотным составом соответствует по всем показателям качества и безопасности требованиям нормативных документов.

Исследования проводились в рамках проекта ИРН AP08053397 по теме «Разработка технологии жировых продуктов со сбалансированным жирнокислотным составом».

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Section 3. Transport

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INTERMODAL AND MULTIMODAL CONTAINER SERVICES

The article observes the concepts of intermodal and multimodal transportation of goods, the organization of their service in a crisis, the benefits of switching to intermodal and multimodal transportation, programs for the development of intermodal and multimodal services in Russia and the European Union. The relevance of the topic is determined by the increase in the volume of intermodal and multimodal transport, the need to ensure better integration of various modes of transport.

In 1996, at the UNCTAD International Conference on Multimodal Transportation, intermodal transportation was interpreted as a generic concept for all types of transportation (intermodal, multimodal, segmental and combined), denoting the transportation of goods by several modes of transport, in which one of the carriers undertakes to organize the entire transportation of cargo from the point of departure to the final destination ("door-to-door"), while depending on the distribution of responsibility between carriers, various transport documents are issued [1]. In multimodal transportation, the carrier organizing the delivery of cargo on the principle of "door-to-door" assumes responsibility for the entire process as a whole [1].

In the joint document of the UNECE, ECMT and the EU "Terminology of Combined Transport" of 2001, multimodal transport is the transportation of goods by two or more modes of transport, intermodal transport is defined as the sequential transportation of goods by two or more modes of transport in the same cargo unit (loadingunit) or motor vehicle (road vehicle) without overloading the cargo itself when changing the mode of transport. Intermodal transport unit (ITU), in accordance with this document, are containers, removable bodies (swap bodies) and semitrailers suitable for intermodal transportation [2].

Thus, in intermodal transportation, the distinctive features are the presence of intermodal transport units, and the use of non-transshipment technologies: cargo delivery is carried out by two or more modes of transport in the same cargo unit without overloading the cargo itself when changing the mode of transport. At all stages of the transportation process, the operator links the actions of all participants in the supply chain: cargo owners, carriers in order to speed up the cargo delivery process while minimizing costs. Multimodal transportation is organized by the operator on the basis of a multimodal transportation contract, responsible for the entire transportation, carried out according to a single document, in domestic or international communication by two or more modes of transport.

The increase in the share of intermodal and multimodal transportation in the total volume of cargo transportation is associated not only with the development of global supply chains, increased attention to the environmental friendliness of transport, but also with the difficult situation in seaports during the crisis. Port congestion, vehicle downtime has led to an increase in rates, sea freight has increased significantly. The amount of freight is established by agreement of the parties, in the absence of an agreement of the parties, the amount of freight is calculated based on the rates applied at the place of loading of the cargo and during loading of the cargo [3]. By the end of 2021, the Baltic Dry freight cost index, which tracks the prices for sea transportation of bulk and bulk cargo around the world, increased by more than 60% due to increased demand for the transportation of goods against the backdrop of the global economic recovery, disruption of existing supply chains, problems in ports. The demand and prices for container transportation have also increased, the cost of sending a container from Asia to Europe has increased almost 10 times during the pandemic [4].

Changes in the container transshipment market by the end of 2021 based on data from the Global Ports Group of companies, one of the main operators of container and multipurpose terminals in Russia, managing a network of five sea container terminals in Russia and two in Finland, as well as a logistics complex near St. Petersburg: the Russian container transshipment market reached record volumes and amounted to 5.4 million TEU (+7.1% by 2020), the growth of cargo turnover occurred both in the segment of containerized imports (+11.1% by 2020) and exports (+4.2% by 2020) [5]. Thus, in the context of a sharp increase in freight rates on the international market, an increase in the volume of container traffic and a global shortage of empty containers, companies continued to choose faster import and export supply chains with the least sea leverage and the use of intermodal/multimodal service.

The growth of the Russian container market in 2021 was concentrated in two basins: the Far East (+14.0% by 2020) and the Azov-Black Sea (+6.4% by 2020), container turnover of terminals in St. Petersburg and the Leningrad Region decreased by 3.7% [6]. In addition, due to the shortage of rolling stock and the need for mass delivery of platforms to the ports of the Far East from almost all over the country, the cost of cargo removal and terminal processing has increased. Additional costs associated with the supply of rolling stock in increased volumes are included in the rate by railway operators, the excess daily cost of using and storing equipment in ports has increased, the time standard has decreased [7].

During the crisis caused by a failure in supply chains due to congestion of ports, disruption of their normal operation due to the pandemic, intermodal and multimodal container services have become in demand, allowing for the delivery of goods both in international and domestic communications. The most optimal way of delivery in terms of price and speed of delivery is rail transport. It is advisable to include air traffic in the delivery chain for small volumes and the delivery of valuable cargo. Road transport is limited in terms of traffic volume and has the most negative impact on the environment (the share in total emissions of pollutants into the atmosphere is 46.7%, in the noise impact on the urban population 85–95%) [8].

Thanks to the introduction of transportation by several modes of transport, transportation costs are reduced, the efficiency of managing goods and transport flows is increased, the coordinated development of communication routes and terminal facilities reduces specific investments in logistics infrastructure, switching cargo flows from road to other modes of transport reduces environmental pollution[9].

In order to strengthen the country's geostrategic positions, consolidate and expand global competitive advantages, a significant increase in the competitiveness of the transport system in the international transport services market is required, for which it is necessary to develop the transport infrastructure of various modes of transport, including increasing the pace of introduction of intermodal and multimodal technologies, primarily container transportation [8]. Economic growth, socio-economic development and the security of the state depend on the transport complex, the most important basic branch of the economy.

Transport corridors passing through the territory of Russia do not have the required technical characteristics, sufficient capacity of ports and border points [8]. The priorities and objectives of the state program of the Russian Federation "Development of the transport system" are: active integration into the system of international transport corridors, increasing the competitiveness of Russian carriers, increasing the volume and speed of transit traffic, development of multimodal and intermodal logistics technologies, checkpoints across the state border of the Russian Federation [8]. To achieve these goals, it is necessary to solve the following tasks [8]:

- to form a single reference transport network;
- eliminate infrastructure constraints;
- develop multimodal, intermodal, transport and logistics technologies;
- upgrade vehicles of all modes of transport;
- increase the capacity of the existing transport network;
- coordinate the development of competing communications of different modes of transport.

The transport policy of the European Union is aimed at the development of intermodal and multimodal transport, which optimally combine different modes of transport, using the strengths of each and minimizing disadvantages, ensuring sustainable, energy-efficient and environmentally friendly operation of the transport complex. Road transport has the most negative impact on the environment: pollution, climate change, noise create problems for the economy, health and well-being of citizens. The growth of road freight transport is projected by 40% by 2030 and a little more than 80% by 2050, so the use of multimodal transport, a reduction in the share of road transport, the use of modes of transport that are less polluting and more energy efficient, is an urgent problem of the European Union [10].

Programs have been developed in the European Union for the development and maintenance of intermodal and multimodal technologies [10]:

- internalization of external costs for all modes of transport. The social and environmental costs of transport should be paid in accordance with the "polluter pays" principle;
- targeted infrastructure investments aimed at improving interconnections between unimodal networks;
- efficient use of information (about traffic, capacity, availability of infrastructure, location of goods and vehicles);
- Direct support for intermodal transport: The EU provides financial support for multimodal/intermodal transport.

The EU multimodality policy is aimed at ensuring better integration of modes of transport and establishing interoperability at all levels of the transport system, while using the advantages of various modes of transport (convenience, speed, cost, reliability, predictability), the combination of which can offer more efficient transport solutions for cargo delivery, reduce the load on overloaded sections of the network, make the whole the sector is more environmentally friendly, safe and cost-effective [10].

During the crisis caused by the COVID19 pandemic and its consequences, the transport complex found itself in difficult conditions, many well-established logistics supply chains were disrupted, solving the problems that arose, shippers and carriers were forced to look for alternative ways of delivering goods. The increasing harmful impact on the environment and the health of the population redistributes cargo traffic from automobile, which occupies a leading position in environmental pollution, to more environmentally friendly – rail transport. High freight rates, port congestion, and environmental safety issues have intensified the transition of the service from segmentation by mode of transport to intermodality and multimodality of container transportation. Intermodal cargo delivery schemes pass through Russian ports (St. Petersburg, Ust-Luga, Nakhodka, Novorossiysk, Vladivostok), Baltic ports (Riga, Klaipeda, Tallinn), the main directions are: European countries – remote regions of Russia; Europe – Central Asia; China, Turkey – CIS countries. New intermodal container services are organized from the countries of Southeast Asia through the port of Vladivostok and further to Novorossiysk, Rostov-on-Don and St. Petersburg. The main advantages of intermodal and multimodal container service are:

- reduction of delivery time;
- optimal cost of transportation, especially for long distances and transcontinental routes;
- environmental friendliness (negative impact on the environment is reduced due to minimal use of motor transport);
- cargo safety (use of one cargo unit, lack of access to cargo);
- minimal time and energy spent on loading and unloading operations,
- the possibility of using a container for temporary storage of cargo.

The current state of the transport complex does not fully meet the needs of socio-economic development. The problems of transport accessibility of the Far East, including the carrying and carrying capacity of the Baikal-Amur and Trans-Siberian railways, have not been solved [8]. The implementation of the state program "Development of the transport system" creates additional opportunities for the development of the Russian transport system and further improvement of its production, information and technological infrastructures, the use of intermodal and multimodal technologies for cargo transportation, will accelerate the growth of exports of transport services.

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Section 4. Chemistry

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PRODUCTION OF BLACK PEPPER AND GINGER OLEORESIN USING ULTRASOUND EXTRACTION METHOD

Abstract. New and interesting extraction methods can be created when ultrasound is used in conjunction with conventional extraction methods. Ginger and black pepper oleoresins were extracted using ultrasound in this study. The extraction yield and efficiency of black pepper and chilli were also studied using propane and dimethyl ether, respectively. The pungency of the extracts was determined using an NMR technique developed specifically for this project. Extracts of ginger and black pepper were also tested for their volatile content. Acetone was used to extract all of the different types of spices so that the yields could be compared. Subcritical dimethyl ether was just as effective as supercritical carbon dioxide in extracting the pungent components from the spices, but it also extracted a significant amount of water. When ultrasonics was used, the extraction was done with ethanol as the solvent and the temperature was set to 60 degrees Celsius. The oleoresin that was extracted had a distinct ginger flavour and was a dark, thick liquid. Ginger oleoresin was found to be unaffected by ultrasound use, according

to GC–MS analysis. Zingerone was the primary ingredient in ginger and black pepper oleoresin that had been extracted. Detection of gingerol, one of the pungent components of ginger oleoresin, was not possible because gingerol decomposes at temperatures above 45 degrees Celsius. Ultrasound-assisted extraction had an extraction rate that was 1.75 times faster than a conventional soxhlet system. An additional piece of evidence for ultrasound's mechanical effects can be found in the images taken with a scanning electron microscope, which show the destruction of cells and the subsequent release of their contents.

Keywords: ginger volatile oil ingredient solvent ultrasound filtration black pepper extract of s. aromatic oils.

Introduction

Throughout history, herbs and spices have been used extensively in traditional medicine and as a colourant, flavorant, and aroma enhancer in human diets. EOs derived from aromatic plants have a wide range of biological properties and have been used in a variety of products for the pharmaceuticals, agronomy, food and sanitary products industries, cosmetics and fragrance industries [1].

Among the Piperaceae family of plants, black pepper (Piper nigrum L.) stands out as a significant agricultural crop that has numerous health and medicinal benefits. South East Asia and China are home to the plant, which is a perennial climber. However, it is widely grown in tropical regions, including India, Brazil, Indonesia, Sri Lanka, Vietnam, and Malaysia. In Asian countries, black pepper is a common spice for flavouring food. Exports from Vietnam account for about a third of the world's total black pepper production, and nearly all of that pepper is consumed in North America, Europe, and India [2].

Additionally, black pepper's anti-inflammatory, antioxidant, antimicrobial, anti-cancer, and anti-inflammatory properties make it a valuable health supplement for preventing chronic illnesses and providing physiological benefits outside of nutrition and flavour. Folk medicine has extensively investigated and utilised these benefits. Piperine, which is primarily found in black pepper essential oil, is one of the compounds responsible for the pungency. As a bioactive component, piperine has been shown to be effective in the treatment of musculoskeletal pain, digestive problems, and respiratory infections. Components that contribute to flavour and aroma include limonene, myrcene, linalool, linalool, myrcene, sabinene, sabinene, germacrene-D, and -caryophyllene. Cosmetics and the food and beverage industries both use black pepper essential oil [3].

Figure 1. Ginger oleoresin

As a cooking spice and medicinal plant, ginger is widely used around the world. Zingiber officinale, a perennial herb in the family Zingiberaceae, is the source of this rhizome. Known to have originated in Asia, the ginger plant spread to India, Southeast Asia, West Africa and the Caribbean over the centuries. Essential oils and oleoresins derived from ginger are widely used in the food and pharmaceutical industries around the world. Gingerols and shogaols are the main pungent compounds in the oleoresin, which is characterised by monoterpenes and sesquiterpenic compounds. Throughout the last few years, researchers have discovered more and more medicinal properties in ginger. In addition to its many other uses, it is an aphrodisiac, digestive aid, rubifacient, anti-asthmatic, and anti-inflammatory. Stomachaches, cardiovascular and motor diseases, and other aches and pains are among the many ailments for which ginger is traditionally used. It also has anti-inflammatory properties, regulates bacterial growth, and protects people with immune system disorders like HIV [1].

Figure 2. Black pepper oleoresin

Ginger has been found to contain a wide range of active ingredients. Because ginger's active ingredient has a high added value, researchers are working to improve extraction methods in order to produce higher-quality extracts with increased yields. Solvent extraction and soxhlet extraction are two examples of techniques that can be used for this purpose. Many studies have found that ultrasound-assisted extraction (UAE) can yield higher extraction yields in a shorter period of time and at lower temperatures for a variety of plant species. UAE is a brand-new technique for obtaining chemical constituents from plant materials. It's safe and efficient. The bubble of cavitation inducing the majority of ultrasonic effects within a material generates intense pressures, shear forces, and temperature gradients, which can produce physical, chemical, and mechanical effects, allowing the chemical constituents to dissolve in the solvent without heating. Plant material solvation can also be facilitated by ultrasound, which causes cell swelling and the expansion of the cell wall pores. Improved swell ability will increase the rate of mass transfer, which will result in a faster healing time [3].

Because of the oil's many applications and the abundance of useful components, extractions are more efficient and take less time because of this. There are numerous benefits to this new method, including a faster dissolution rate of plant constituents, a greater penetration of the solvent, and a higher extraction yield due to the increased movement of the molecules, all of which can be facilitated by ultrasound. For example, the extraction of hemicellulose from buckwheat hull, the extraction of sensitive aroma compounds in garlic, the extraction of essential oil in olives, and the extraction of phenolic compounds from coconut (Cocos nucifera) shell powder have all been reported in recent years. Thermally sensitive constituents used in food, healthcare products, cosmetics, and pharmaceuticals can be extracted using this method. Bioactive principles extracted from plants using ultrasonic extraction have also been reviewed. An alternative to conventional extraction methods such as supercritical fluid and microwave assisted extraction, UAE is a fast, inexpensive, and effective option in many analytical situations.

Literature is becoming increasingly interested in the production of black pepper. A lot of attention has been paid to determining the best extraction methods and operating conditions to maximise spice yields. It was determined that the Zingiberaceae family's ginger and black pepper (Zingiber officinale R.) oleoresin extraction was affected by ultrasound. In addition, a soxhlet extraction method was compared to the UAE extraction method.

Literature Review

Because it is made from finely ground powder, oleoresin can retain the scent and flavour of the plant from which it was derived. Each of these oils has its own distinct flavour. High-pungency Most of the world's supply of Capsicum oleoresin is sourced from India, Africa, and China, where chilli production is concentrated. Many regions produce red pepper oleoresin with a medium heat level. Spain, Ethiopia, Morocco, Israel, India, the United States, Mexico, and South Africa are among the countries that produce paprika oleoresin that is not pungent (Govindarajan, 1986). Chilli or paprika powder is finely ground to extract the oleoresin. The material is thoroughly wetted with a volatile non-aqueous solvent such as hexane, ether, or ethylene dichloride [4].

Micelles are formed when the oleoresin is dissolved in the solvent. Thereafter, fresh solvent is added to continue the extraction process. To prevent the loss of aromatic volatile compounds, the solvent is subsequently evaporatively removed from the extract. First, the solvent is removed in a standard film evaporator, and then a partial vacuum is used to remove all of the remaining solvent and make oleoresin from concentrated micella. Very high vacuum is used to recover any solvent still present in the extracted powder mass. The typical yield of oleoresin ranges from 11.5–16.5 percent depending on the solvent used. The pungency of the oleoresin is determined by the original powder's pungency. Color and flavour are the primary purposes of paprika oleoresin, while CAPS levels in capsicum oleoresin can reach 10%, making it a more potent source of heat [6].

Oleoresins are a type of natural spice extract that can be either liquid, semisolid, or solid, depending on how they were extracted. To make an oleoresin, you'll need a variety of different substances, including essential oils, pigments, volatile compounds, and antioxidants. Essential oil and non-volatile components that are desirable and contribute significantly to the flavour profile are extracted during the oleoresin extraction process. Using a vacuum, a concentrated extract of the oleoresin is removed from the solvent. Oleoresins come in a variety of viscosities and textures, from thin, liquid oils to thick, sticky pastes. These components can't be added directly to food because of this.

Oleoresins are extremely stable in storage and can be kept for up to one year without losing any of their quality. In addition, there are other advantages, such as the fact that they require only 1% to 10% of the space of ground spices. Temperature and humidity-controlled storage isn't always necessary [1].

In the food industry, Sri Lankan black pepper oleoresin is used as a flavouring and colourant. Uses for it include food preservation and flavouring. When it comes to beverages, orange juice is one of those that can take advantage of its ability to preserve. Black pepper oleoresins, rather than synthetic preservatives, are preferred by most juice manufacturers. Also, it can be used to preserve pork and reduce the activity of organisms that cause meat spoilage.

The oleoresin is also known for its aromatic values. Inhaling its strong aroma helps to soothe tightened emotions. It helps to relieve anxious feelings. A few drops of the liquid can be added to a diffuser to experience these benefits. Black pepper oleoresin contains natural chemicals such as monoterpenes and sesquiterpenes that support the immune system. These chemicals help the body to avoid any uncomfortable symptoms during a cold season.

Black pepper oleoresin is a yellowish-brown liquid with a pungent, slightly biting aroma. Its goodness runs deeper into its nutritional value. It is a good source of nutrients such as Thiamine, Riboflavin, Vitamin C, E, B_6, and K. Similar to the spice, the oleoresin of black pepper also contains high amounts of piperine, an alkaloid that is responsible for its sharp taste and pungency. With all its goodness, black pepper can benefit the human body in many ways.

Free radicals naturally created are unstable molecules. They damage cells. Exposure to cigarette smoke, pollution, and sun rays can create these free radicals that eventually lead to health problems such as inflammation, premature ageing, heart disease, and cancer. The intake of antioxidants delays and reduces any harm done by free radicals. Just like any other black pepper product, black pepper oleoresins also contain high amounts of piperine.

Antioxidants can be found in this ingredient. To protect against oxidative damage, in vitro studies have shown that piperine can inhibit the formation of free radicals and reactive oxygen species by quenching them. Black pepper oleoresins or black pepper as a spice, for example, can be consumed on a daily basis. can help an individual to avoid any infections.

Weight gain is a result of both eating behaviour and lifestyle. Eating fatty foods lead to gaining weight. It is followed by many health issues. Adding some black pepper oleoresin to your food can help you lose some weight. The spice itself is a rich source of Vitamins A, C, and K, minerals, and fatty acids. It works as a natural metabolic booster that makes it the reason for a lot of health benefits including weight loss [10].

Consuming food that contains black pepper helps to burn calories hours after eating. It prevents the creation of new fat cells, suppressing fat accumulation. Black pepper oleoresin also promotes gut health. Its nutrients increase the good bacteria present in the gut. This is linked to immune function, mood, chronic diseases, and more.

Black pepper oleoresin's high piperine content protects against the majority of cancers. Selenium, beta-carotene and B vitamins in the intestines can also be absorbed more effectively with this supplement. Preventing colon cancer may be possible with piperine, according to a study in Canada. Additionally, it backed efforts to lower the risk of prostate cancer. Prostate cancer chemotherapy medication docetaxel was found to benefit from the alkaloid [4].

The spice oleoresin's piperine content can also have a positive effect on the health of the brain. It prevents the breakdown of the calming neurotransmitter serotonin by inhibiting an enzyme. Melatonin, a hormone that regulates the sleep-wake cycle, is degraded by this enzyme. The oleoresin of black pepper can also help prevent Parkinson's disease. The feel-good hormone, dopamine, is disrupted by another enzyme that is inhibited by this medication. Dopamine is missing in everyone with Parkinson's disease. These symptoms may be alleviated by consuming black pepper. It's also a good way to stay out of a slump. The piperine content of this supplement is also helpful in preventing cognitive decline and Alzheimer's disease. It also boosts the brain's nerve activity.

Materials and Methods

Materials

Guilin's Chu Se District, in Gia Lai Province (13°49′21″ N108°2′37″ E), provided both the black pepper and ginger seeds used in the research. Using a grinder, black pepper seeds were first picked, dried, and screened (Sunhouse SHD5323, Hanoi, Vietnam). Pre-milling, the pepper was chilled in an Alaska LC-743H refrigerator for two hours at 10 °C in order to minimise the loss of essential material. After that, a wire mesh was used to filter the ground pepper particles (with sizes ranging from 20 to 160 mesh). It was necessary to cool and re-mill any seeds that did not make it through the sifting process. It is necessary to pre-cool materials after milling in order to reduce volatile odors and undesirable smells. An evaporator was used to dissolve sodium chloride (NaCl) in water, which was then added to the flask containing the material. The brine/material suspension was gently shaken before being removed from the flask.

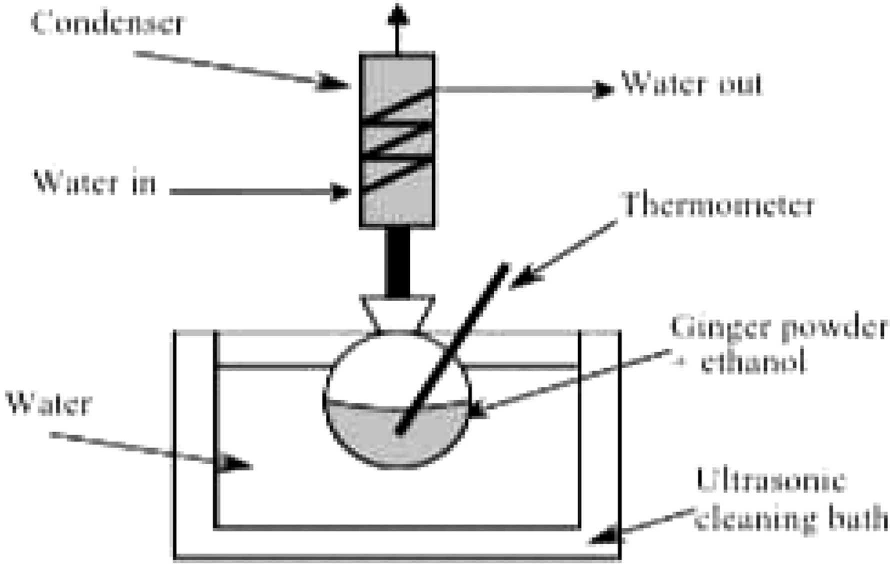

Figure 3. Apparatus used for this experiment

An Indonesian market near the city of Bireun in Aceh province sold fresh ginger rhizomes. There were no small stones or sand or plant leaves left behind after harvesting and transporting the produce. ‘ Afterwards, the ginger rhizomes were cleaned and then peeled. A laboratory grinder was used to grind the peels to a fine powder after they had been sun-dried for more than two days. Particle sizes of ginger powder were evenly distributed on a stainless steel screen with a mesh size of 2 mm. It was then stored in a paper bag at 20 ° C for future use. Analytical-grade chemicals were used for the rest of the experiments. Ultrasonic cleaning baths Bransonic 8510 with a 42 kHz frequency and a digital timer were used in the UAE experiments.

Table 1.– For the Composition of Black pepper and Ginger oleoresin

	CO_2-E1			CO_2-E2			CO_2-E3			CO_2-E4		
	Psd2	Psd3	Psd4	Psd2	Psd3	Psd4	Psd2	Psd3	Psd4	Psd2	Psd3	Psd4
	Composition (mass %)			Composition (mass %)			Composition (mass %)			Composition (mass %)		
2-heptanol	1.00	1.30	1.68	-	-	-	-	-	-	-	-	-
α-pinene	7.29	7.85	3.36	-	-	-	-	-	-	-	-	-
camphene	19.16	20.18	8.91	-	0.45	-	-	-	-	-	-	-
β-myrcene	4.09	4.19	3.20	-	-	-	-	-	-	-	-	-
β-pinene	18.62	19.64	16.91	1.08	1.46	0.51	-	-	-	-	-	-
limonene	2.86	3.05	2.06				-	-	-	-	-	-
m-diethyl benzene	5.01	6.15	3.88	-	-	-	-	-	-	-	-	-
o-diethyl benzene	2.26	2.35	1.62	-	-	-	-	-	-	-	-	-
nonanal	-	-	-	-	-	-	4.20	3.74	4.38	8.56	5.33	13.16
neral	1.43	0.98	2.49	2.80	3.00	3.10	1.62	2.46	1.81	1.01	2.08	1.27
geranial	3.60	2.39	4.47	9.01	6.76	6.64	8.50	7.41	5.46	6.38	6.45	4.01
ar-curcumene	2.48	1.64	3.64	6.12	5.92	6.05	3.64	3.91	3.71	2.63	2.36	1.60
α-zingiberene	17.88	16.94	27.30	45.81	43.72	44.86	35.88	33.93	32.22	26.34	23.76	19.14
farnesene	7.96	7.43	10.72	17.30	18.33	18.60	14.20	12.47	13.44	11.03	9.77	7.53
β-sesquiphellandrene	6.36	5.91	8.50	14.97	14.62	15.32	12.39	10.32	11.00	10.05	8.38	6.30
mixture of gingerols	-	-	-	0.70	0.36	1.10	19.57	25.76	27.98	34.00	36.61	37.74
not identified	-	-	1.26	2.21	5.38	3.82	-	-	-	-	5.26	9.25

Method

A 500 mL flask was filled with 50 g of ginger powder and 150 mL of ethanol was used as a solvent. During the extraction, the temperature was maintained at 60 degrees Celsius. Controlled by a water bath thermometer, temperatures were kept stable. In order to maintain a constant temperature in the bath during ultrasound experiments, cold water had to be added on a regular basis. During the replacement, make sure that the bath water level remains constant. The internal extraction vessel's temperature was monitored and found to be constant to within 1 degree Celsius. The extract was cooled to room temperature after extraction. A water pump was used to filter the extract, and then it was concentrated in a rotary evaporator. HP G 1800C Series II GCD system was used for GC–MS analysis of HP-5MS column with 30 m × 0.25 mm and 0.25 m film thickness (Hewlett-Packard, Palo Alto, USA). Carriage gas was Helium [7].

The injector and detector were both set to 260 degrees Celsius. Comparing mass spectra of the extract to those from Wiley 275 and NIST/NBS libraries identified the components. Calibrated Done by robots Mass Spectral Systemic disease and Identification Software Application (AMDIS ver.2.1.) was used to compare the experimental retention index values to published literature, and this data was then used to confirm the validity of the MS findings. A field emission scanning electron microscope, the Hitachi S-3500N, was used to image ginger particles. One mm thick slices of ginger were used for this purpose. Duplicates of each sample were prepared and analysed. Soxhlet was used to perform the conventional extraction in the same manner as described previously for the United Arab Emirates. For comparison, this was used as a control [7].

Using the Heating Mantle User Manual heater, 20 g of black pepper was heated with the Clevenger gear (Bach Được Ltd., Ho

Chi Minh City, Laos) after it being immersed in water in NaCl solution for the required time (1000.EU.05, 300 W, Glassco Laboratory Equipment Pvt. Ltd., Ambala Cantt, India). The extraction stage experimental set-up is shown. As soon as the first drop of shortened crude extract is dropped into the oil extraction system, the extraction timer begins. To preserve the essential oil, sodium sulphate (Na_2SO_4) is used to dehydrate it and store it in a storage tank at 10 °C after the harvesting process has been completed.

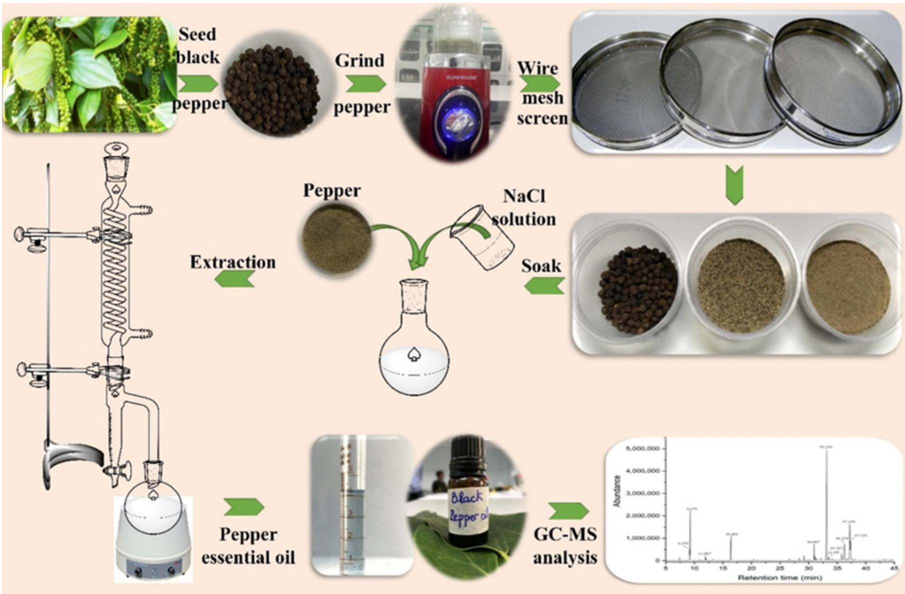

Figure 4. Methodology of experiment

Black pepper essential oil extraction was examined in this study, which looked at factors such as material size, preservation conditions, NaCl solution concentration and time, and distillation conditions. In the first place, whole seeds, mesh 40, and mesh 160 were all taken into consideration as material sizes, with the latter two representing filtration after grinding at 40 and 160 mesh sizes, respectively. Afterwards, the effect of raw material preservation was also examined by taking into account various conditions, such as heat flux (° c and cold storage of 10 °C), lid state, and time of preservation (24–72 h). The NaCl solution concentration and soak time ranged from 1–5 percent and from 1–5 hours, respectively, and were also investigated. Also examined were factors such as extraction time (1–6 h) and temperature (130–200 °C) as well as the ratio of raw material to solvent (0.5–1/35 g/mL). The response surface and single-factor methods were used to fine-tune these experimental conditions (RSM).

Result and Discussion

Each experiment yielded a dark, thick liquid with a distinct ginger flavour, which was consistent across all samples. With the help of GC–MS, we were able to identify a wide range of components in the extract. Here we can see a typical total-ion chromatogram from a GC–MS analysis of components extracted from ginger oleoresin. Table 1 displays the GC–MS results of the oleoresin components analysis. Only five of the composition's major constituents are highlighted. The results from the soxhlet as well as those from Zancan et al. are included in the table as well. Component zingerone was the most abundantly detected by GC–MS analysis, as shown in Table, whether it was extracted using UAE or conventionally using a soxhlet. Soxhlet and UAE were able to identify 113 and 112 components, respectively, in the GC–MS results. These findings suggest that the GC–MS difference was small, indicating that ultrasonication had little effect on changes in ginger oleoresin components. Gingerol, one of the pungent ingredients in ginger oleoresin, was not detected by the results of GC–MS.

Essential oils and oleoresins derived from ginger are widely used in the food and pharmaceutical industries around the world. Gingerols and shogaols are the main pungent compounds in the oleoresin, which is characterised by monoterpenes and sesquiterpenic compounds. Throughout the last few years, researchers have discovered more and more medicinal properties in ginger. In addition to its many other uses, it is an aphrodisiac, digestive aid, rubifacient, anti-asthmatic, and anti-inflammatory. Stomachaches, cardiovascular and motor diseases, and other aches and pains are among the many ailments for which ginger is traditionally used. It also has anti-inflammatory properties, regulates bacterial growth, and protects people with immune system disorders like HIV [1].

Ginger has been found to contain a wide range of active ingredients. Because ginger's active ingredient has a high added value, researchers are working to improve extraction methods in order to produce higher-quality extracts with increased yields. Solvent extraction and soxhlet extraction are two examples of techniques that can be used for this purpose. Many studies have found that ultrasound-assisted extraction (UAE) can yield higher extraction yields in a shorter period of time and at lower temperatures for a variety of plant species. UAE is a brand-new technique for obtaining chemical constituents from plant materials. It's safe and efficient. The bubble of cavitation inducing the majority of ultrasonic effects within a material generates intense pressures, shear forces, and temperature gradients, which can produce physical, chemical, and mechanical effects, allowing the chemical constituents to dissolve in the solvent without heating. Plant material solvation can also be facilitated by ultrasound, which causes cell swelling and the expansion of the cell wall pores. Improved swell ability will increase the rate of mass transfer, which will result in a faster healing time [3].

Table 2. – Yield of Ginger and black pepper oleoresin

Time (min)	**Oleoresion yield(%)**	
	UAE	**Soxhlet**
1	**2**	**3**
30	5.50	–
60	6.50	–

1	2	3
120	6.80	–
180	7.28	–
240	7.43	–
300	7.81	–
420	–	7.48

At higher temperatures (above 45 degrees Celsius), gingerol will decompose into zingerone and shogaol, which reduces the amount of gingerol present. In addition, the thermal degradation of gingerols to shogaols makes it difficult to identify and quantify the compounds using gas chromatography. Meanwhile, significant amounts of the ginger oleoresin's other pungent constituents, zingerone and shogaol, were found. The yield of oleoresin from ultrasonic and conventional soxhlet extraction processes is shown in the table below. Table shows that the UAE yielded 7.43 percent in 240 minutes, while soxhlet extraction yielded almost the same in 420 minutes. In the UAE, extraction rates of oleoresin were 1.75 times faster than with a conventional soxhlet system. Additionally, this shows that the UAE is 50% more efficient in terms of time than soxhlet extraction. Ji et al. state that the solvent diffusion in a substance can be enhanced by ultrasound, and that the ultrasound cavity's influences extend beyond the particles themselves to the substance's core. Ultrasonic extraction of fat from plant seeds takes less time and yields a similar amount of product than soxhlet extraction, according to Garcia and Castro. Hesperidin extraction from Citrus reticulata peel has also shown a similar trend, according to Ma et al. This is due to the fact that a longer extraction time increases the likelihood of solvent contact with the material.

The peeling process was necessary because the outer peels of the black pepper were so thick and hard that the extraction process could be hindered. As a result, treatment must be tailored to fit each patient's unique needs. Figure shows that as the size of the black pepper decreased, the amount of oil it produced increased. With no peeling, the lowest yield of 0.25 percent was achieved; with peeling, the yields were 1.6 percent and 1.8 percent, respectively [9].

When black pepper is crushed, oil-containing cells are broken, making it easier for water to get into the oil-filled bags. Consequently, the Clevenger apparatus is powered by steam. It also has a natural scent and is a light green colour, as opposed to the seed size material, which is a light yellow colour as a result of prolonged heat exposure. as shown in Figure 5's examination. The emulsion was formed during the extraction process when essential oils and water were mixed together. In addition to reducing the solubility of some non-polar components of essential oil in the water medium, adding salt to the extraction mixture could prevent the loss of essential oil as emulsion. As an electrolyte, sodium chloride (NaCl) plays an important role in increasing the water's density and polarization, which makes the separation of essential oil from water more convenient [10].

Oil yield decreases as NaCl concentration rises above 2%. An osmotic pressure difference between the external environment and the oil-containing cells could be the cause of this phenomenon. Water inside the cell is effectively osmosed out, making it difficult to separate essential oils from the substance. In the same extraction conditions, a NaCl concentration of 2% yielded the best results, while a concentration of 4%–5% yielded the worst results. For this reason, 2 percent NaCl is chosen as the optimal concentration for the best yield of essential oil. When the mixture of water and material is heated, the water vapour penetrates the layer of the skin, which contains home remedies, breaks down the fundamental oils, and draws the oil by steam. Essential oil cannot escape if the colloids and salts encasing the pouch are not sufficiently dissolved by the water.

As illustrated, adding more water to the extraction process increases oil diffusion into the water, increasing solubility and increasing the yield of soluble components. Rather than emulsifying or dissolving the oil, too much water could cause it to become diluted or emulsified, reducing the amount of oil produced and the distillation's economic efficiency. Figure 7 shows that although both the 1/20 (g/mL) and 1/25 (g/mL) ratios gave the highest yield oil (2.2%), the 1/20 (g/mL) ratio could save a significant amount of water and, as a result, bring high economic value with only a marginal reduction in yield. This led to the decision to use a ratio of 1/20 (g/mL) for the next survey. The yield of black pepper essential oil increases as the extraction temperature or time increases. However, when the yield of essential oil reached an optimum level, as depicted in Figure 8, it stopped increasing. High temperature decomposition of some components resulted in the highest yield of oils at 180 °C (2.25%), and the lowest yield of 1.95% at 200 °C.

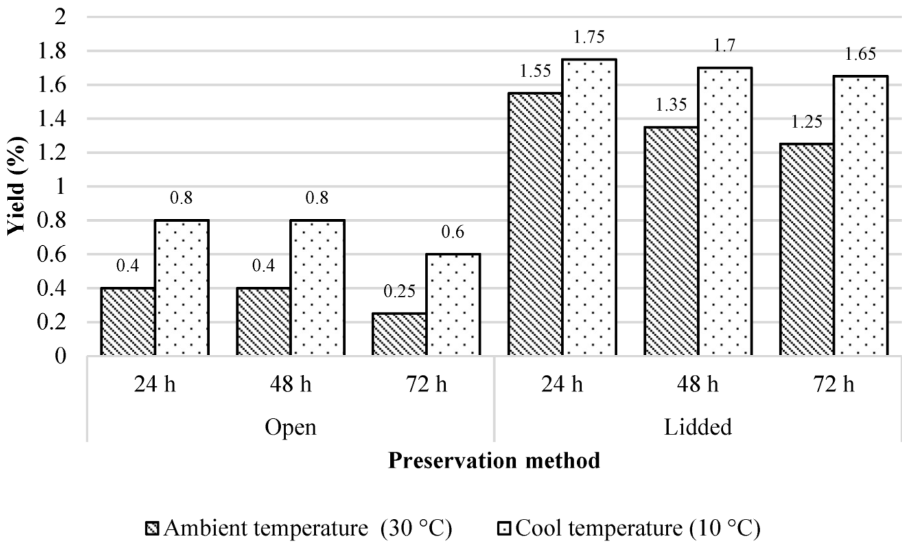

Figure 5.

Graphical Representation of Yield

Due to a small amount of material being splashed in and burned, the essential oil is light yellow at both temperatures. Due to the oil's green colour and lack of denaturation, a temperature of 150 °C is preferred over one of 180 °C for several reasons. After 5 hours of extraction, the extraction yield stopped increasing, as shown in Figure 9. As a result, the extraction time was set at five hours. Table summarised the findings. The essential oil of black pepper contains 26 compounds that make up 99.86% of the total compounds. Other unknown compounds in the oils were insignificant. There were only trace amounts of compounds that were less than 0.5%. The major constituents of black pepper essential oil, according to our research, are 3-carene (29.21 percent), D-limonene (20.94 percent), -caryophyllene (15.05 percent), -pinene (4.69 percent), and -pinene (9.77 percent). 3-carene and Dlimonene concentrations were significantly higher than those found in other black pepper cultivars in previous studies. When extracting -caryophyllene using the same conditions as black pepper from India, the compound was found to have a lower concentration. In addition, Vietnamese black pepper oil does not contain sabinene, unlike other black pepper cultivars.

In order to extract more material, the extraction time must be increased until the solvent becomes saturated. It's also important to note that as extraction time increases, so does the amount of heat that is absorbed, which in turn speeds up the diffusion process. However, as shown in Table, the oleoresin yield does not change significantly for extraction times greater than 60 minutes. This may be due to the fact that the ultrasonic effect was at its peak about 60 minutes before extraction, so the change in extraction time did not result in a significant yield change. Ultrasonics, according to Balachandran et al., will boost mass transfer's effective diffusivity, and this effect will be at its peak within a short period of time.

SEM images of the plant cells after extraction were taken to demonstrate the disruption effect of ultrasonic vibration on the physical structure of ginger particles. SEM images of ginger particles at a magnification of 250 are shown in the figure. The results of the experiment show that ultrasonic vibration can cause cell structures to be damaged. When the solvent can reach the internal particle structure, it is easier to remove the cell's contents. Scanning electron microscopy images of ginger particles show: a) results from experiments using ultrasound and; b) results from experiments not involving ultrasound. Intra-particle dispersion will also be improved by this method. The cell disruption was smaller in scale in the experiment without ultrasound, but the SEM images show similar phenomena. A greater understanding of UAE's mechanism will necessitate more research to determine the individual effects of high-intensity ultrasound and extraction parameters such as temperature, pressure, or solvent type.

Conclusion

In the extraction of oleoresins, ultrasound has the potential to reduce processing time. A mechanical effect caused by ultrasonically induced cavitation was blamed for the results, which increased plant tissue permeability. Analyses of ultrasonicate ginger oleoresin's main components by gas chromatography did not reveal any significant changes. However, gingerol, one of the oleoresin's pungent constituents, was not detected because, at temperatures higher than 45 degrees Celsius, gingerol decomposes to zingerone and shogaol. After extracting the ginger, a scanning electronic microscopy analysis was performed. An extraction ratio of 1:21 g/mL water to material, an extraction temperature of 150 °C, and an extraction time of 5.2 hours were found to be optimal. A temperature of 10 degrees Celsius for lidded storage is also recommended for the materials.

There are numerous benefits to this new method, including a faster dissolution rate of plant constituents, a greater penetration of the solvent, and a higher extraction yield due to the increased movement of the molecules, all of which can be facilitated by ultrasound. For example, the extraction of hemicellulose from buckwheat hull, the extraction of sensitive aroma compounds in garlic, the extraction of essential oil in olives, and the extraction of phenolic compounds from coconut (Cocos nucifera) shell powder have all been reported in recent years. Thermally sensitive constituents used in food, healthcare products, cosmetics, and pharmaceuticals can be extracted using this method. Bioactive principles extracted from plants using ultrasonic extraction have also been reviewed. An alternative to conventional extraction methods such as supercritical fluid and microwave assisted extraction, UAE is a fast, inexpensive, and effective option in many analytical situations.

2.45 percent optimum efficiency was achieved under these conditions. In addition, gas chromatography-mass spectrometry was used to identify 26 essential oil compounds in black pepper (GCMS). Among the most abundant compounds in the essential oil were 3-carene (29.21 percent), D-limonene (20.94 percent), -caryophyllene (15.05%), -pinene (9.77 percent), and -pinene (4.69 percent). We can conclude from our findings that the essential oil from Vietnamese black pepper is useful in the production of insecticides and air fresheners. It's clear from the images that ultrasound works. Using high-intensity ultrasound to extract oleoresin from plant sources may reduce extraction time and thus increase production throughput in commercial processes.

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Contents