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Public Health Threat: Detection of Undeclared Dexamethasone and Paracetamol in Jamu Marketed in Kudus, Indonesia

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A B S T R A C T

Jamu, Indonesia's traditional herbal medicine, holds significant cultural and medicinal value. However, the adulteration of jamu with undeclared synthetic drugs like dexamethasone and paracetamol poses a severe public health risk. This study aimed to qualitatively identify these drugs in jamu products circulating in Kudus City, Indonesia. Ten jamu samples, representing various brands and forms (powder, capsules), were purchased from local depots in Kudus. Samples were selected based on their indication for pain relief or anti-inflammatory properties, lack of BPOM (Indonesia's Food and Drug Authority) registration, or discrepancies between the registration number on the packaging and the BPOM database. Organoleptic analysis (odor, taste, color, form) was performed, followed by microscopic analysis to identify natural ingredients using their characteristic fragments. Finally, infrared spectroscopy was employed to detect the presence of dexamethasone and paracetamol. Nine out of ten samples displayed BPOM registration numbers that were not verifiable in the official BPOM database, while one sample lacked any registration number. Organoleptic analysis revealed that six samples exhibited distinct herbal odors, often associated with bitter-tasting jamu. Microscopic analysis confirmed the presence of 1-4 natural ingredients in each sample. Notably, infrared spectroscopy identified paracetamol in one sample. In conclusion, the study revealed a concerning trend of unregistered jamu products and adulteration with undeclared paracetamol in Kudus City. This highlights the need for stricter regulatory measures, enhanced surveillance, and public awareness campaigns to ensure the safety and efficacy of jamu.

1. Introduction

Traditional medicine, also known as complementary and alternative medicine (TCAM), is a broad and diverse field encompassing a wide range of health practices, knowledge, and beliefs. It is deeply rooted in the cultural heritage and traditions of communities worldwide, representing a holistic approach to health and well-being that has evolved over centuries. Traditional medicine systems, such as Traditional Chinese Medicine (TCM), Ayurveda, and various indigenous healing practices, have played a vital role in maintaining the health of millions of people across the globe. Traditional medicine is characterized by its emphasis on the interconnectedness of the mind, body, and spirit, recognizing the individual as a whole rather than focusing solely on the disease. It often incorporates natural remedies, manual therapies, spiritual practices, and lifestyle modifications to prevent and treat illnesses, promote health, and enhance overall well-being. The World Health Organization (WHO) recognizes the importance of traditional medicine in meeting the health needs of populations worldwide, particularly in areas where access to conventional healthcare is limited. Traditional medicine is often more accessible and affordable than conventional medicine, making it an essential part of primary healthcare in many communities. Moreover, traditional medicine can

provide culturally appropriate and patient-centered care, which is crucial for addressing the diverse health needs and preferences of individuals and communities.[1,2]

Traditional medicine has the potential to make significant contributions to public health, particularly in the areas of disease prevention, health promotion, and primary healthcare. Many traditional medicine practices emphasize preventive measures, such as healthy diets, regular exercise, stress management, and lifestyle modifications, which can help to reduce the risk of chronic diseases and promote overall health. In addition, traditional medicine can play a vital role in primary healthcare, particularly in underserved and remote areas where access to conventional healthcare is limited. Traditional healers often serve as the first point of contact for health concerns in these communities, providing essential healthcare services and contributing to the overall well-being of the population.[3,4]

Jamu, a traditional herbal medicine deeply ingrained in Indonesian culture, holds significant cultural and medicinal value. It is an integral part of Indonesia's rich heritage, representing a holistic approach to health and wellness that has been passed down through generations. Jamu is widely consumed in Indonesia and other parts of Southeast Asia, both as a daily health tonic and as a remedy for various ailments. The Indonesian government recognizes the importance of Jamu and has implemented policies to support its development and promote its use. The BPOM (Indonesia's Food and Drug Authority) is responsible for regulating Jamu products to ensure their quality, safety, and efficacy. However, the increasing adulteration of Jamu with undeclared synthetic drugs poses a significant public health threat, undermining the integrity of this traditional medicine and jeopardizing consumer safety. Adulteration is the intentional addition of undeclared substances to a product, often with the intent to deceive consumers or lower production costs. In the context of Jamu, adulteration typically involves the addition of synthetic drugs, such as dexamethasone and paracetamol, to enhance its perceived efficacy or mimic its therapeutic effects. The adulteration of Jamu with undeclared synthetic drugs poses a severe public health risk. Consumers who believe they are taking natural Jamu products may be unknowingly exposed to the potential adverse effects of these drugs. This can lead to delayed or improper medical treatment, drug interactions, and exacerbation of existing health conditions.[5,6]

Dexamethasone, a potent corticosteroid, is often illegally added to Jamu for its anti-inflammatory and analgesic effects. While dexamethasone has legitimate therapeutic uses, its long-term use can lead to severe adverse effects, including hyperglycemia, osteoporosis, growth retardation in children, and Cushing's syndrome. Paracetamol, a commonly used analgesic and antipyretic, is also found in adulterated Jamu. While generally safe at recommended doses, excessive or prolonged paracetamol consumption can cause liver damage and other complications. The presence of these undeclared synthetic drugs in Jamu not only undermines the integrity of traditional medicine but also deceives consumers who believe they are taking natural products. This deception can have serious health consequences, as consumers may not be aware of the potential risks and interactions associated with these drugs.[7,8]

The adulteration of Jamu with undeclared synthetic drugs is a growing public health concern in Indonesia and other countries where Jamu is consumed. This practice not only threatens consumer safety but also undermines the cultural and medicinal value of Jamu. There is an urgent need for research to understand the extent of Jamu adulteration and its impact on public health. This research should include qualitative and quantitative studies to identify the types and levels of adulterants in Jamu products, as well as epidemiological studies to assess the health consequences of Jamu adulteration. In addition to research, there is a need for stricter regulatory measures, enhanced surveillance, and public awareness campaigns to combat the adulteration of Jamu. These efforts should involve collaboration

among government agencies, researchers, healthcare professionals, and the Jamu industry to ensure the quality, safety, and efficacy of Jamu products.[9,10] This study aimed to qualitatively identify the presence of dexamethasone and paracetamol in Jamu products circulating in Kudus City, Indonesia.

2. Methods

This qualitative study was conducted in Kudus City, Indonesia, between March and April 2024 to assess the quality and safety of Jamu products. The study involved the collection and analysis of ten Jamu samples, which were purchased from various depots in Kudus. The samples were selected based on specific criteria, including their indication for pain relief or anti-inflammatory properties, lack of BPOM registration, or discrepancies between the registration number on the packaging and the BPOM database. The study employed a multi-faceted approach to analyze the Jamu samples, incorporating organoleptic analysis, microscopic analysis, and infrared spectroscopy analysis.

The selection of Jamu samples was a crucial step in the study design, as it aimed to ensure the representativeness of the sample and the validity of the study findings. The selection criteria were carefully defined to target Jamu products that were more likely to be adulterated with synthetic drugs; Indication for pain relief or anti-inflammatory properties: Jamu products marketed for pain relief or anti-inflammatory properties are more likely to be adulterated with synthetic drugs like dexamethasone and paracetamol, as these drugs offer quick and potent effects; Lack of BPOM registration: Jamu products without a BPOM registration number may not have undergone the necessary quality and safety checks, increasing the risk of adulteration and other quality issues; Discrepancies in BPOM registration: Jamu products with a BPOM registration number that could not be verified on the official BPOM website raise concerns about the authenticity of the registration and the potential for adulteration.

Organoleptic analysis, also known as sensory analysis, is a method used to evaluate the physical characteristics of a product using the human senses. In the context of this study, organoleptic analysis was performed to assess the color, odor, taste, and form of each Jamu sample. The organoleptic properties of Jamu products can provide valuable insights into their quality and authenticity. For instance, the color of a Jamu product can indicate the presence of certain ingredients or adulterants. The odor and taste can also be indicative of the quality and authenticity of the Jamu, as well as the presence of any unusual or unexpected ingredients. The form of the Jamu, whether it is in powder, capsule, or liquid form, can also be relevant to its quality and potential for adulteration.

Microscopic analysis is a technique used to identify the components of a sample by examining it under a microscope. In this study, microscopic analysis was conducted to identify the natural ingredients present in the Jamu samples. A small portion of each Jamu sample was mounted on a glass slide and examined under a microscope at 10x and 40x magnifications. The observed microscopic features were compared with reference images to identify the characteristic fragments of various plant materials commonly used in Jamu. Microscopic analysis is a valuable tool for quality control in the production of Jamu. It allows for the identification of the plant species used in the Jamu, ensuring that the product contains the intended ingredients. This analysis can also help to detect the presence of any foreign materials or contaminants, such as starch grains, mold spores, or insect fragments, which could indicate adulteration or poor quality.

Infrared (IR) spectroscopy is a technique used to identify the chemical components of a sample based on their characteristic absorption of infrared radiation. In this study, IR spectroscopy was employed to detect the presence of dexamethasone and paracetamol in the Jamu samples. A small amount of each sample was prepared using the potassium bromide (KBr) pellet technique. The prepared pellets were then

analyzed using an IR spectrophotometer. The resulting spectra were compared with the standard spectra of dexamethasone and paracetamol to identify any characteristic peaks. IR spectroscopy is a powerful tool for detecting adulteration in Jamu products. It can identify the presence of specific chemical compounds, even in complex mixtures like Jamu. This technique is particularly useful for detecting synthetic drugs that may have been added to the Jamu, as these drugs have distinct IR spectra that can be easily identified.

The data collected from the organoleptic analysis, microscopic analysis, and infrared spectroscopy analysis were compiled and analyzed to assess the quality and safety of the Jamu samples. The findings were then interpreted to draw conclusions about the prevalence of adulteration in Jamu products in Kudus City and the potential public health implications. The study also examined the BPOM registration status of the Jamu samples to assess compliance with regulatory requirements. The findings highlighted the prevalence of unregistered Jamu products in the market, raising concerns about the lack of quality control and the potential risks to consumer safety.

The study was conducted in accordance with ethical research practices. The Jamu samples were purchased from local depots, and no human subjects were involved in the study. The study findings were reported accurately and transparently, and the limitations of the study were acknowledged.

3. Results and Discussion

Table 1 presents the BPOM (Indonesia's Food and Drug Authority) registration status of ten Jamu samples collected in Kudus City. A striking nine out of ten Jamu samples displayed BPOM registration numbers that were not verifiable in the official BPOM database. This indicates that these products, despite bearing registration numbers, are essentially unregistered and likely operating outside the regulatory framework. This raises serious questions about their quality and safety, as they have not undergone the necessary scrutiny by the authorities. One sample lacked any BPOM registration number whatsoever, further emphasizing the presence of Jamu products in the market that completely bypasses regulatory oversight. This widespread lack of valid BPOM registration suggests a significant problem with the authenticity and quality control of Jamu products in Kudus City. It indicates that a considerable portion of the Jamu market may be operating in a regulatory grey area, potentially exposing consumers to health risks. The findings underscore the urgent need for stricter enforcement of BPOM regulations and enhanced surveillance to ensure that Jamu products meet the required quality and safety standards. This is crucial to protect public health and maintain consumer trust in this important aspect of Indonesian traditional medicine.

Table 1. BPOM registration status.

Sample	Registration Number	Status
A	POM TR 025 889 121	Not registered
B	POM TR 0432 30691	Not registered
C	POM TR 090234332	Not registered
D	TDP 1328580999	Not registered
E	TDP 110 826 0074	Not registered
F	No registration number	Not registered
G	POM TR 008 261 819	Not registered
H	POM TR 053 348 358	Not registered
I	POM TR 124 000 315	Not registered
J	POM TR 083 275 091	Not registered

Table 2 provides a detailed account of the organoleptic properties (sensory characteristics) of the ten Jamu samples analyzed in the study. The samples exhibit a diverse range of colors, from white and pale white to yellowish-brown, bright yellow, pink, and brown. This variation is expected, as Jamu

formulations often incorporate different plant materials with varying pigmentation. However, the bright yellow color observed in samples C and F could indicate the addition of synthetic dyes, a potential adulteration tactic used to enhance the visual appeal of the product. This warrants further investigation. Six out of the ten samples presented a "distinctive herbal" odor. This is generally a positive indication, suggesting the presence of authentic herbal ingredients commonly used in Jamu preparations. Interestingly, samples A, E, and G were odorless. While some Jamu formulations may naturally lack a strong odor, the absence of any discernible herbal scent in these samples could raise questions about their ingredient composition or processing methods. A predominant bitter taste was noted across most samples, which aligns with the typical flavor profile of many traditional Jamu recipes. Sample I, with its "slightly spicy, bitter" taste, suggests a unique blend of ingredients that might include spices known for their therapeutic properties in Jamu. The majority of the samples were in powder form, a common presentation for Jamu products. Two samples (E and G) were in tablet form, indicating a more processed and potentially standardized manufacturing approach. Sample I stood out with its "small granules" form, suggesting a different preparation method or the inclusion of specific ingredients that lend themselves to this texture.

Table 2. Organoleptic analysis.

Sample	**Color**	**Odor**	**Taste**	**Form**
A	White	Odorless	Tasteless	Powder
B	Yellowish-brown	Distinctive herbal	Bitter	Powder
C	Bright yellow	Distinctive herbal	Bitter	Powder
D	White	Distinctive herbal	Bitter	Powder
E	Pink	Odorless	Bitter	Tablet
F	Bright yellow	Distinctive herbal	Bitter	Powder
G	Pinkish-white	Odorless	Bitter	Tablet
H	Pale white	Distinctive herbal	Bitter	Powder
I	Brown	Distinctive herbal	Slightly spicy, bitter	Small granules
J	Pale white	Distinctive herbal	Bitter	Powder

Table 3 presents the findings of the microscopic analysis conducted on the ten Jamu samples. This analysis aimed to identify the natural ingredients present in each sample by examining their microscopic characteristics. The analysis successfully identified a variety of natural ingredients across the samples, confirming the use of various plant materials in Jamu formulations. These include common Jamu components like ginger (*Zingiber officinale*), black pepper (*Piper nigrum*), turmeric (*Curcuma longa*), and galangal (*Alpinia galanga*), as well as other ingredients like fennel (*Foeniculum vulgare*), noni fruit (*Morinda citrifolia*), mangosteen (*Garcinia mangostana*), and *Centella asiatica* (Gotu kola). Some samples contained only a single identifiable ingredient (e.g., samples A, B, C, D, E, and H), while others were more complex, with up to four identified ingredients (e.g., samples F and G). This variation reflects the diversity of Jamu recipes and the potential for combining different herbs for synergistic effects. While microscopic analysis can identify characteristic fragments of plant materials, it has limitations in differentiating closely related species or detecting adulteration with plant powders that lack distinct microscopic features. This highlights the need for complementary analytical techniques, such as DNA barcoding or chemical profiling, to confirm the botanical identity and purity of the ingredients. Importantly, the microscopic analysis did not reveal any unexpected or foreign materials in the samples, such as starch grains, mold spores, or insect

fragments, which could indicate adulteration or poor quality. However, this method cannot detect the presence of synthetic drugs, which require different analytical techniques like IR spectroscopy for identification.

Table 3. Microscopic analysis.

Sample	Natural ingredients identified
A	Ginger (*Zingiber officinale*)
B	Black pepper (*Piper nigrum*)
C	Fennel (*Foeniculum vulgare*)
D	Noni fruit (*Morinda citrifolia*)
E	Mangosteen (*Garcinia mangostana*)
F	Turmeric (*Curcuma longa*), Noni fruit (*Morinda citrifolia),* Black pepper (*Piper nigrum*)
G	Piper retrofractum, Black pepper (*Piper nigrum*), Galangal (*Alpinia galanga*)
H	*Centella asiatica* (Gotu kola)
I	*Curcuma xanthorrhiza*, Ginger (*Zingiber officinale*)
J	Javanese turmeric (*Curcuma xanthorrhiza*), Galangal (*Alpinia galanga*)

Table 4 presents the results of the infrared (IR) spectroscopy analysis, a crucial step in this study designed to detect the presence of dexamethasone and paracetamol in the ten Jamu samples. Paracetamol was detected in one out of the ten Jamu samples (Sample H). This finding confirms the adulteration of this specific Jamu product with a synthetic drug, highlighting a serious breach of quality and safety standards. The presence of undeclared paracetamol poses potential health risks to consumers, especially those who may unknowingly exceed the recommended dosage or have underlying health conditions. Dexamethasone was not detected in any of the ten samples. This suggests that, within this limited sample set, adulteration with dexamethasone may be less prevalent than with paracetamol. However, it's crucial to remember that this study only analyzed a small number of Jamu products from a specific region. Further research with larger sample sizes and broader geographical coverage is needed to draw more definitive conclusions about the prevalence of dexamethasone adulteration in Jamu. The findings underscore the critical role of IR spectroscopy in detecting adulteration in Jamu products. This technique can identify specific chemical compounds, even in complex mixtures like Jamu, making it a valuable tool for quality control and consumer protection.

Table 4. Infrared spectroscopy analysis.

Sample	Dexamethasone	Paracetamol
A	Not detected	Not detected
B	Not detected	Not detected
C	Not detected	Not detected
D	Not detected	Not detected
E	Not detected	Not detected
F	Not detected	Not detected
G	Not detected	Not detected
H	Not detected	Detected
I	Not detected	Not detected
J	Not detected	Not detected

The presence of undeclared synthetic drugs in jamu presents a significant public health risk. Consumers, often drawn to jamu for its perceived natural and safe qualities, may unknowingly be exposed to the potential adverse effects of these hidden pharmaceuticals. This adulteration can lead to delayed or improper medical treatment, dangerous drug interactions, and the exacerbation of existing health conditions, ultimately jeopardizing the well-being of unsuspecting individuals. Paracetamol, also known as acetaminophen, is a widely used over-the-counter analgesic and antipyretic, commonly found in medications used to relieve pain and reduce fever. While generally safe when taken as directed, excessive or prolonged consumption of paracetamol can have serious consequences, particularly for the liver. The undeclared presence of paracetamol in jamu can lead to accidental overconsumption. Consumers, unaware of the paracetamol content in their jamu, may simultaneously take other medications containing paracetamol, such as cold and flu remedies or prescription painkillers. This unintentional stacking of paracetamol-containing products can quickly lead to exceeding the maximum recommended daily dose, putting individuals at risk of liver damage. The liver plays a crucial role in metabolizing paracetamol. When taken in excess, the liver's detoxification pathways become overwhelmed, leading to the accumulation of a toxic metabolite called N-acetyl-p-benzoquinone imine (NAPQI). NAPQI can cause severe damage to liver cells, potentially leading to liver inflammation, liver failure, and even death. Individuals with pre-existing liver conditions, such as hepatitis or cirrhosis, are particularly vulnerable to paracetamol-induced liver damage. Their livers are already compromised, making them less able to handle the toxic effects of excessive paracetamol. Similarly, those who consume alcohol regularly put additional strain on their livers, increasing their susceptibility to paracetamol-related liver injury. Symptoms of paracetamol-induced liver damage can range from mild to severe. Mild symptoms may include nausea, vomiting, loss of appetite, and fatigue. More severe symptoms can include jaundice (yellowing of the skin and eyes), abdominal pain, dark urine, and pale stools. In advanced cases, hepatic encephalopathy (confusion, disorientation, and coma) and liver failure can occur. Dexamethasone, a potent corticosteroid medication, is another drug commonly found in adulterated jamu. It is often added for its powerful anti-inflammatory and analgesic effects, providing quick relief from pain and swelling. However, long-term exposure to dexamethasone can have a wide range of adverse effects, impacting various systems in the body. Dexamethasone can disrupt glucose metabolism, leading to elevated blood sugar levels (hyperglycemia), insulin resistance, and an increased risk of developing type 2 diabetes. These metabolic disturbances can have cascading effects on cardiovascular health, increasing the risk of heart disease, stroke, and other complications. Prolonged use of dexamethasone can interfere with bone metabolism, leading to osteoporosis, a condition characterized by decreased bone density and an increased risk of fractures. This is particularly concerning for older adults and those with pre-existing bone conditions, who are already at a higher risk of fractures. In children, dexamethasone can suppress growth hormone production, leading to growth retardation and delayed development. This highlights the importance of keeping dexamethasone out of the reach of children and ensuring that jamu products are not marketed towards children if they contain such undeclared synthetic drugs. Dexamethasone can disrupt the delicate balance of hormones in the body, potentially leading to Cushing's syndrome. This condition is characterized by a range of symptoms, including weight gain, a rounded face (moon face), a fatty hump between the shoulders (buffalo hump), easy bruising, thinning skin, and muscle weakness. Additionally, long-term use of dexamethasone can suppress the adrenal glands, leading to adrenal insufficiency. This condition occurs when the adrenal glands do not produce enough cortisol, a hormone essential for regulating various bodily functions. Symptoms of adrenal insufficiency can include fatigue, weakness, weight loss, low blood pressure, and

nausea. Dexamethasone can suppress the immune system, making individuals more susceptible to infections. This can be particularly dangerous for individuals with compromised immune systems, such as those with HIV/AIDS or those undergoing chemotherapy. The potential adverse effects of undeclared synthetic drugs in jamu highlight the critical importance of proper labeling and regulation of jamu products. Consumers have the right to know what ingredients are present in the products they consume, especially when those products may contain potent drugs with potential for harm. Clear and accurate labeling of jamu products is essential to ensure consumer safety. Labels should clearly list all ingredients, including any synthetic drugs, along with their quantities. This will allow consumers to make informed decisions about their health and avoid potential adverse effects. In addition to labeling, strong regulatory measures are needed to ensure the quality and safety of jamu products. Regulatory bodies, such as the BPOM in Indonesia, need to enforce strict registration requirements, conduct regular inspections of jamu producers, and implement rigorous testing to detect adulteration. Violations should be met with appropriate penalties to deter adulteration practices and protect public health. Healthcare professionals play a crucial role in educating patients about the potential risks of adulterated jamu. They should inquire about patients' use of jamu and other traditional remedies, advising them of the potential for adulteration and the associated health risks. Healthcare professionals should also be vigilant in recognizing the symptoms of adverse drug reactions that may be linked to adulterated jamu.[11-13]

The adulteration of jamu with undeclared synthetic drugs strikes at the very heart of traditional medicine, undermining its integrity and eroding the trust consumers place in it. This betrayal of consumer confidence has profound implications, not only for individuals seeking natural healthcare options but also for the future of jamu and the broader landscape of traditional medicine. Consumers who choose jamu are often motivated by a desire for natural healing. They believe in the power of traditional remedies, passed down through generations, to promote health and well-being without the potential side effects associated with conventional pharmaceuticals. Jamu, with its roots in ancient Indonesian wisdom and its use of natural ingredients, embodies this promise of holistic healing. However, the presence of undeclared synthetic drugs in jamu products shatters this promise. It transforms a trusted natural remedy into a deceptive concoction, blurring the lines between traditional healing and conventional medicine. This adulteration not only misleads consumers but also undermines the very essence of jamu, eroding its authenticity and cultural significance. Consumers who purchase jamu have a right to expect that the product is what it claims to be a natural herbal remedy. The addition of synthetic drugs without proper disclosure is a form of deception, a betrayal of the trust that consumers place in jamu producers and sellers. This violation of trust can have far-reaching consequences, extending beyond the individual consumer to impact the reputation of jamu and traditional medicine as a whole. When consumers discover that jamu products have been adulterated with synthetic drugs, they may feel misled and disappointed. This can lead them to question the safety and efficacy of not only jamu but also other traditional remedies. The adulteration of jamu casts a shadow of doubt on the entire system of traditional medicine, potentially discouraging consumers from exploring natural healthcare options in the future. This erosion of trust can also influence consumers' choices regarding healthcare providers. They may become less likely to consult traditional healers or practitioners of traditional medicine, opting instead for conventional healthcare options. This shift away from traditional medicine can limit consumers' access to a holistic approach to health and well-being that incorporates traditional knowledge and practices. Traditional medicine often emphasizes a holistic approach to health, considering the interconnectedness of mind, body, and spirit. It may

incorporate a variety of modalities, such as herbal remedies, acupuncture, massage, and dietary changes, to address the root causes of illness and promote overall well-being. By discouraging consumers from seeking traditional medicine options, jamu adulteration may deprive them of the potential benefits of this holistic approach. The erosion of trust caused by jamu adulteration can have even broader implications for the traditional medicine system as a whole. It can fuel skepticism and doubt about the efficacy and safety of traditional remedies, even those that are genuinely natural and beneficial. This skepticism can undermine the credibility of traditional medicine practitioners and discourage individuals from pursuing careers in this field. Moreover, the negative publicity surrounding jamu adulteration can create a stigma around traditional medicine. This stigma can make it more difficult for traditional medicine practitioners to gain recognition and acceptance within the broader healthcare system. It can also hinder efforts to integrate traditional medicine into mainstream healthcare, limiting the potential benefits that traditional medicine can offer to a wider population. Restoring consumer trust in jamu and traditional medicine will require a concerted effort from all stakeholders. Jamu producers and sellers need to prioritize quality control and ensure that their products are free from adulteration. They must adhere to ethical manufacturing practices and be transparent about the ingredients in their products. Regulatory bodies need to strengthen their oversight of the jamu industry and enforce strict penalties for adulteration practices. This includes regular inspections of production facilities, rigorous testing of jamu products, and swift action against those who violate regulations. Public awareness campaigns are also crucial to educate consumers about the risks of adulterated jamu and to promote the proper use of traditional remedies. These campaigns can highlight the cultural and historical significance of jamu and other traditional medicines, emphasizing their value in promoting health and well-being. Furthermore, collaboration between traditional medicine practitioners and conventional healthcare providers can help to bridge the gap between these two systems of care. By working together, they can provide patients with a more comprehensive and integrated approach to health and well-being.[14,15]

The consequences of jamu adulteration extend far beyond the immediate risks to individual health. This deceptive practice sends shockwaves through the Indonesian economy and chips away at the cultural foundations upon which jamu has been built for centuries. The presence of counterfeit and adulterated jamu products in the market not only undermines fair competition and threatens the livelihoods of those who produce authentic jamu but also erodes the cultural heritage and traditional knowledge associated with this time-honored practice. The jamu industry plays a vital role in the Indonesian economy, supporting a complex network of farmers, producers, distributors, and sellers. This intricate ecosystem relies on consumer trust and fair competition to thrive. However, the influx of counterfeit and adulterated jamu products disrupts this delicate balance, creating an uneven playing field where genuine producers struggle to survive. Counterfeit jamu products often lure consumers with their deceptively low prices. These products, however, may be made with substandard ingredients, improper formulations, or even harmful additives, posing a significant risk to consumer health and undermining the reputation of authentic jamu. As consumers become wary of the quality and safety of jamu, the demand for genuine products may decline, jeopardizing the livelihoods of those who depend on the jamu industry for their income. The economic pressures created by adulterated jamu can also discourage the production of authentic, high-quality jamu. As producers struggle to compete with the artificially low prices of counterfeit products, they may be forced to cut corners or compromise on quality to remain competitive. This can lead to a downward spiral, where the overall quality of jamu products deteriorates, further eroding consumer trust and damaging the industry's reputation. Furthermore, the presence of adulterated jamu can

stifle innovation. Producers who invest time, resources, and passion into developing new and improved jamu formulations may be hesitant to bring their products to market, fearing that their innovations will be quickly copied or counterfeited. This reluctance to innovate can hinder the growth and development of the jamu industry, limiting its potential to contribute to public health and economic prosperity. Jamu is more than just a medicinal product, it is an integral part of Indonesian culture and heritage, woven into the fabric of society for centuries. Its origins can be traced back to ancient traditions, where knowledge of herbal remedies was carefully passed down through generations, often within families or close-knit communities. Jamu is deeply embedded in the cultural fabric of Indonesia, playing a role in rituals, ceremonies, and daily life. The practice of adulterating jamu undermines this rich cultural heritage. It disrespects the traditional knowledge and practices associated with jamu production, reducing this ancient tradition to a mere commodity to be exploited for profit. This erosion of cultural heritage can have a profound impact on Indonesian identity and sense of belonging, severing ties to ancestral wisdom and undermining cultural pride. The adulteration of jamu also poses a threat to the traditional knowledge and practices associated with its production. As producers cut corners or replace traditional ingredients with synthetic substitutes, the intricate knowledge of herbal remedies and their careful preparation may be lost. This knowledge, accumulated over generations through observation, experimentation, and cultural transmission, represents a valuable asset to Indonesian society. The loss of this traditional knowledge can have far-reaching consequences, not only for the jamu industry but also for the preservation of Indonesia's cultural heritage and biodiversity. Traditional knowledge of medicinal plants often goes hand-in-hand with sustainable harvesting practices and the conservation of plant diversity. As this knowledge fades, so too may the practices that help to protect Indonesia's natural environment. Preserving the cultural heritage of jamu requires a multi-faceted approach that involves the active participation of various stakeholders. It requires supporting genuine jamu producers, promoting the proper use of traditional remedies, and educating consumers about the value of authentic jamu. It also necessitates protecting traditional knowledge and practices, ensuring that they are passed on to future generations. Government agencies can play a crucial role in preserving the cultural heritage of jamu by implementing and enforcing regulations that protect against adulteration and promote fair competition. They can also support research into the efficacy and safety of traditional remedies, integrate jamu into healthcare settings, and develop educational programs to raise awareness about the cultural significance of jamu. Industry associations can contribute by establishing quality standards for jamu products, promoting ethical manufacturing practices, and supporting the professional development of jamu producers. They can also work with cultural organizations to preserve traditional knowledge and practices, ensuring that they are passed on to future generations. Consumers also have a role to play in preserving the cultural heritage of jamu. By choosing to purchase authentic jamu products from reputable producers, they can support the industry and encourage the preservation of traditional knowledge and practices. They can also educate themselves about the cultural significance of jamu and share this knowledge with others.[16-18]

The findings of this study, coupled with the broader implications of jamu adulteration, underscore the urgent need for comprehensive and multi-faceted action to address this pressing issue. Protecting public health, preserving cultural heritage, and ensuring the integrity of traditional medicine require a collaborative effort involving government agencies, industry stakeholders, researchers, healthcare professionals, and consumers. The Indonesian government, particularly the BPOM (Indonesia's Food and Drug Authority), needs to strengthen its regulatory framework for jamu products. This includes

implementing stricter registration requirements, conducting more frequent inspections of jamu producers, and imposing harsher penalties for adulteration. The registration process for jamu products should be made more rigorous, requiring detailed information about the ingredients, manufacturing processes, and quality control measures. This will help to ensure that only products that meet strict quality and safety standards are allowed on the market. Regular inspections of jamu production facilities are essential to verify compliance with regulations and to detect any adulteration practices. These inspections should be conducted by qualified personnel with the expertise to identify potential adulterants and assess the quality of jamu products. The penalties for adulterating jamu products should be severe enough to deter this practice. This could include hefty fines, product recalls, and even the suspension or revocation of licenses for repeat offenders. Surveillance and monitoring of the jamu market need to be enhanced to identify and remove adulterated products from circulation. This can involve collaboration between government agencies, researchers, and consumer protection organizations. Regular testing of jamu products should be conducted after they have entered the market to detect any adulteration that may have occurred after the initial registration process. This can involve random sampling of products from retail outlets and testing them for the presence of undeclared synthetic drugs. Encouraging whistleblowers to report any suspicious activities related to jamu adulteration can help to identify and address this issue more effectively. This could involve establishing confidential reporting mechanisms and providing protection for whistleblowers. Collaborating with researchers to develop more sophisticated and efficient methods for detecting adulteration in jamu products can enhance surveillance efforts. This could involve developing new analytical techniques or refining existing methods to improve their sensitivity and accuracy. Public awareness campaigns are crucial to educate consumers about the risks of adulterated jamu and to empower them to make informed choices. These campaigns can also promote the proper use of jamu and encourage consumers to report any suspicious products. Developing educational materials, such as brochures, pamphlets, and online resources, can help to inform consumers about the potential risks of adulterated jamu and how to identify authentic products. These materials should be widely disseminated through various channels, including healthcare facilities, community centers, and online platforms. Utilizing various media platforms, such as television, radio, and social media, can help to reach a wider audience and raise awareness about jamu adulteration. These campaigns can feature testimonials from individuals who have been affected by adulterated jamu, as well as expert advice from healthcare professionals and researchers. Engaging with communities through workshops, seminars, and other outreach programs can help to educate consumers about jamu adulteration and promote the proper use of traditional remedies. This can also provide an opportunity to address any concerns or misconceptions that consumers may have about jamu. The jamu industry has a responsibility to ensure the quality and safety of its products. Industry associations and individual producers should actively participate in efforts to combat adulteration and promote good manufacturing practices. Industry associations can play a role in self-regulation by establishing quality standards for jamu products and promoting ethical manufacturing practices. This could involve developing a code of conduct for jamu producers and implementing certification programs to recognize those who meet these standards. Implementing traceability systems can help to track jamu products throughout the supply chain, from the sourcing of ingredients to the final point of sale. This can help to identify the source of any adulteration and prevent contaminated products from reaching consumers. The jamu industry should actively collaborate with regulatory bodies, such as the BPOM, to address the issue of adulteration. This could involve sharing information about adulteration practices,

participating in consultations on regulatory frameworks, and supporting public awareness campaigns.[19,20]

4. Conclusion

This study has illuminated the concerning reality of Jamu adulteration in Kudus City, Indonesia. The presence of undeclared paracetamol in Jamu products, coupled with the widespread lack of valid BPOM registration, underscores the urgent need for stricter regulatory measures, enhanced surveillance, and public awareness campaigns. The adulteration of Jamu with undeclared synthetic drugs not only poses significant public health risks but also erodes consumer trust and undermines the cultural and medicinal value of this traditional medicine. Protecting public health, preserving cultural heritage, and ensuring the integrity of traditional medicine require a collaborative effort involving government agencies, industry stakeholders, researchers, healthcare professionals, and consumers. Further research is needed to comprehensively assess the extent of Jamu adulteration across Indonesia and to evaluate the effectiveness of interventions aimed at combating this issue. By working together, stakeholders can ensure the safety and efficacy of Jamu, preserving this vital aspect of Indonesian traditional medicine for future generations.

5. References

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