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Review on application of spectrophotometry UV-Vis for identifying BKO in Jamu

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Abstract

WHO reports that herbal medicines are used by more than 75% of the world's population, especially in developing countries, in an effort to maintain health. Jamu is an Indonesian cultural heritage made from herbal ingredients which has a great opportunity to become an export commodity. However, Indonesia is in the top 20 biopharmaceutical exporting countries in the world with a market share still below 0.70%. The main strategy that producers of jamu must undertake is to improve the quality of jamu to maintain the reputation this product and enhance global competitiveness. However, in fact, the presence of pharmaceutical chemicals drug material or in Indonesia it is called "Bahan Kimia Obat" abbreviated as BKO in jamu is still found, this of course reduces the quality and image of Indonesia, so as a consequence there is a need to develop a reliable method to identify BKO ingredients using spectrophotometry UV-Vis. This review highlighted some articles about analytical methods spectrophotometric UV-Vis comprise sample preparation, types of effective solvents, as well as the advantages and disadvantages of identifying BKO, namely diclofenac sodium, sibutramine hydrochloride, paracetamol, and dexamethasone which are applied for jamu safety studies. Articles were searched online over a period of 10 years, using keywords on trusted websites. The UV-Vis spectrophotometry analysis method reviewed can be applied for daily analysis to identify jamu containing BKO such as sodium diclofenac, sibutramine hydrochloride, paracetamol, and dexamethasone. The solvents that provide effective results in the analysis are ethanol for sodium diclofenac, dexamethasone, and paracetamol, while sibutramine hydrochloride uses aquadest as the solvent.

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Keywords

Adulteration, Dexamethasone, Diclofenac sodium, Herbal medicine, Paracetamol

Introduction

The World Health Organization (WHO) reports that more than 75% of the world's population consumes herbal medicine, and 179 out of 194 countries still utilize

traditional medicine [1] . Jamu, a type of traditional medicine, is renowned for its efficacy and safety, trusted for generations, and widely consumed in developing countries. In Indonesia, the tradition of using herbal medicine is deeply ingrained, with nearly 50% of the population consuming jamu and 4.5% consuming it daily. The jamu consumed ranges from homemade preparations and traditional remedies to industrial products [2]. According to a 2018 survey by the Health Research and Development Agency (Balitbangkes) [3], Traditional medicine in product form has become the primary choice for the public, with a usage rate reaching 48%. This figure is higher compared to homemade traditional concoctions, used by 31.8% of the population, and traditional health services (YANKESTRAD), utilized by 31.4%. This trend has spurred the growth of the herbal medicine industry in Indonesia.

Jamu is a mixture of natural ingredients such as plants, animals, minerals, or extracts (galenical) that have been used for generations to maintain health and treat illnesses. It is often considered safe for long-term consumption due to its minimal side effects. The use of jamu is widespread, ranging from rural to urban areas, serving as an alternative to boost immunity and address various diseases. Moreover, it remains a cherished cultural heritage that continues to play a significant role in public health today [4][5][6].

The safety of herbal medicines consumed by the public has been guaranteed by the government through the establishment of regulations, namely the Indonesian Ministry of Health Regulation Number 007 of 2012 on the Registration of Traditional Medicines. This regulation prohibits the distribution of traditional medicines containing chemical substances (BKO), ensuring that herbal products available in the market are safe for use [7]. However, findings from BPOM investigations and several studies report that counterfeit jamu still exists, with the presence of chemical substances (BKO) found in some products. This, of course, diminishes the quality and tarnishes Indonesia's image [8][9][10][11]. The development of reliable analytical methods to identify the presence of chemical substances (BKO) using spectrophotometry UV-Vis is necessary as a consequence. Analytical methods using spectrophotometry UV-Vis have been developed by several researchers in recent years to detect the presence of chemical substances (BKO) in jamu. However, a review of sample preparation, effective solvents, as well as the advantages and limitations of identifying BKO—particularly sodium diclofenac, sibutramine hydrochloride, paracetamol, and dexamethasone—applied to jamu safety studies has not yet been conducted. Additionally, there is a lack of analysis regarding the types of jamu that are widely consumed.

The aim of this study is to review the profile of popular types of jamu, the names of jamu indicating their benefits, sample preparation, effective solvents, as well as the advantages and limitations of identifying chemical substances (BKO)—particularly sodium diclofenac, sibutramine hydrochloride, paracetamol, and dexamethasone—using the UV-Vis spectrophotometry method.

Research Methods

The research method used was a literature study through the collection, reading, analysis, and evaluation of scientific works published in recent years to obtain an overview of sample preparation, effective solvents, as well as the advantages and limitations of identifying chemical substances (BKO)—particularly sodium diclofenac, sibutramine hydrochloride, paracetamol, and dexamethasone—using the UV-Vis spectrophotometry method. The Population, Intervention, Control, and Outcome (PICO) approach was used as the method for searching articles.

Search media

The article search was conducted using the Google Scholar and Sinta databases. The article search was conducted by applying the PICO method combined with inclusion and exclusion criteria. The Population (P) category included sodium diclofenac, sibutramine, dexamethasone, and paracetamol found in jamu. The Intervention (I) category involved the use of solvents for sample preparation and the mobile phase. Meanwhile, the Comparison (C) category included the UV-Vis spectrophotometry method. In the Outcome (O) category, the data analyzed included wavelength values, absorbance, and concentration. The articles obtained from the search using the PICO method combined with inclusion and exclusion criteria were reviewed.

Article extraction

Keywords used in the search within the database included several models such as: BKO names like sodium diclofenac, sibutramine hydrochloride, paracetamol, and dexamethasone; UV-Vis spectrophotometry method; chemical substances in jamu; traditional medicine; and determination of sibutramine hydrochloride content. These keywords were effectively combined in both Indonesian and English. The search strategy was limited by several filters: articles from the last 10 years, full-text selection, and articles in either Indonesian or English.

Data analysis

The research results were presented in the form of percentage diagrams, complemented by descriptions of the types of jamu most commonly used, the names of jamu indicating their benefits, the methods of sample preparation, the solvents most frequently used and their correlation with the results, as well as the advantages and limitations in identifying BKO, particularly sodium diclofenac, sibutramine hydrochloride, paracetamol, and dexamethasone, using the UV-Vis spectrophotometry method.

Results and Discussion

The literature search in Google Scholar and Sinta databases shows that the UV-Vis spectroscopy method is developed and widely used to detect the practice of BKO counterfeiting in jamu. UV-Vis spectrophotometry is an analytical method that examines the interaction between electromagnetic radiation and pharmaceutical compounds by

measuring light absorption in the ultraviolet region (200-400 nm) for colorless compounds, and in the visible light region (400-800 nm) for colored compounds. The UV-Vis spectrum is a spectral band produced from the relationship between absorbance as the ordinate and wavelength as the abscissa.

The article search process is conducted by applying the PICO method, combined with inclusion and exclusion criteria. The Population (P) category includes sodium diclofenac, sibutramine, dexamethasone, and paracetamol in jamu. The Intervention (I) category involves solvents in sample preparation and the mobile phase. The Comparison (C) category is UV-Vis spectrophotometry. The Outcome (O) category includes wavelength values, absorbance, and concentration values. The total number of articles obtained from the literature search is 24, with 43.47% of the articles analyzing BKO sodium diclofenac, 17.39% sibutramine, 21.74% dexamethasone, and 17.39% paracetamol. When considering the names of jamu that also indicate their benefits, the review articles are grouped into 7 categories: pegel linu jamu at 52.17%, jamu for back pain, rheumatism, gout, and arthritis at 4.35% each, slimming jamu at 17.39%, and weight-gain jamu at 13.04%. The data is presented in Figure 1.

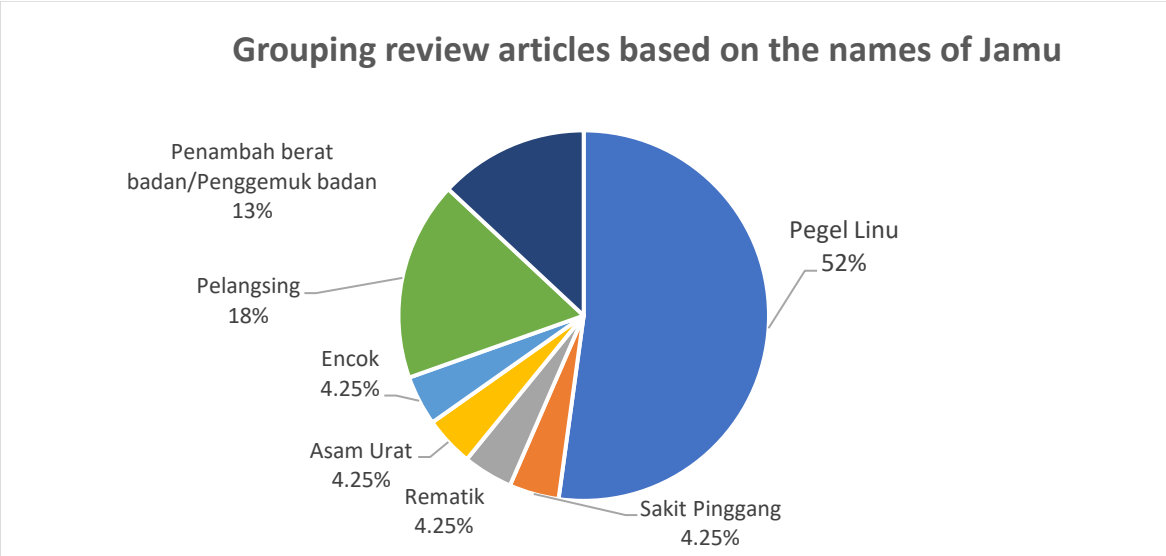

Figure 1. Data of grouping review article

Figure 1 shows that the review articles analyzing "pegel linu" jamu rank first, followed by "Pelangsing", "penambah berat badan/penggemuk badan" and jamu for conditions like "rematik," "asam urat," and "sakit pinggang," all with the same percentage. Pegel linu jamu is one type of traditional Indonesian jamu specifically formulated to relieve muscle soreness, pain, and fatigue after work or daily activities [12], making it highly popular among the public and a favorite choice compared to "gemuk badan" jamu.

The data in Table 1 shows that the sample preparation method used for the analysis of sodium diclofenac, which is commonly used and provides the smallest analyzable concentration of 0.01%, is the filtration method. For the analysis of sibutramine and dexamethasone, the maceration method is used to prepare the samples before analysis in all the journals, while for the analysis of paracetamol, all the journals use the filtration

method. Both maceration and filtration are methods that do not involve heating during the sample extraction process, which helps prevent sample degradation due to heat [34].

Table 1. Review Articles on BKO Sodium Diclofenac, Sibutramine, Dexamethasone, and Paracetamol in Jamu

Journal Code	Preparation Method	Solvent	Wavelength	The concentration range found in several samples in the review journal.
ND1 [4]	Filtration	ethanol 96%	280	6,91 - 15 mg/g
ND2 [13]			276	0.67 - 0.99 mg
ND3 [14]		ethanol	276	2.44 - 5.61 mg/g
NF4 [15]		methanol	276	10.73- 16.11 mg
ND5 [16]		ethanol	230	0,01 %
ND6 [17]		ethanol 96%	270	14.16 ppm
ND7 [18]			275	2.67 - 39.27%
ND8 [19]			276	4.9%
ND9 [20]			232	-
ND10 [21]	Liquid-liguid extraction	ethanol	260	-
SL1 [22]	Maceration	aqua bidestilata	223.5	0.015- 0.029 %
SL2 [23]			266	4.062 - 9.759 %
SL3 [5]			230	1 - 2.5%
SL4 [24]			223	5.83 - 8.93 %
SL5 [25]			223	5.07- 8.37 %
DXT1 [26]		ethanol	240	0.77-1.06 %.
DXT2 [27]		methanol	241.11	0.11- 1.30 %
DXT3 [7]			239	1.14 - 2.49 %
DXT4 [28]	Maceration	chloroform dan aquadest (1:2)	254	1.17 %
DXT5 [29]		methanol dan aquadest (1:1)	234	0.10 - 0.12 %
PCT1 [30]	Filtration	ethanol	245	0.12 - 0.48 %
PCT2 [31]			254.5	8.1 - 9.45 %
PCT3 [32]			254	6.28 - 8.13 mg/kg
PCT4 [33]			245	-

The solvents used in the analysis of sodium diclofenac are 90% ethanol and 10% methanol. Both of these solvents are organic solvents, which are in accordance with the pharmacopoeia, as sodium diclofenac is soluble in organic solvents [35]. The concentration range that can be analyzed in the pegel linu jamu sample with ethanol as the solvent is 0.01 – 39.27%, while with methanol as the solvent, it is 2.44 - 5.61 mg/g. In all the review articles analyzing sibutramine with the UV-Vis spectrophotometry method, the type of solvent used in sample preparation is reported. This is consistent with the solubility of sibutramine hydrochloride, which dissolves in water. Aquadest is an inexpensive and safe solvent for dissolving sibutramine. The concentration that can be analyzed in slimming jamu samples is 0.01 - 9.759%. The solvents used in the analysis of dexamethasone are organic solvents (ethanol or methanol) and combinations of

organic solvents with water (chloroform with water or methanol with water), as dexamethasone is not soluble in water. The concentration of dexamethasone that can be detected in appetite-stimulating jamu samples is 0.10 - 2.49%. The review articles analyzing paracetamol with the UV-Vis spectrophotometry method also report that all tested jamu samples contain paracetamol, with a concentration range of 0.12 - 9.45%. The effective solvent for analysis is ethanol.

Conclusion

Spectrophotometry UV-Vis is a reliable method for detecting pharmaceutical adulterants (BKO) in jamu, such assodium diclofenac, sibutramine hydrochloride, dexamethasone, and paracetamol. Filtration and maceration are simple sample preparation methods, and the selection of solvents based on sample polarity supports accurate analysis without damaging the sample. The practical implications of these findings particularly in ensuring the safety of jamu on the market, providing guidelines for laboratories to enabling the detection of BKO at low concentrations. Furthermore, this analysis can assist regulatory agencies in monitoring the presence of BKO in jamu more efficiently, supporting better regulatory interventions and enhancing consumer trust in safe and high-quality jamu

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