Preparation of Nanoparticles from *Curcuma longa* L. and *Cosmos caudatus* Extracts

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**Abstract.** This study aims to prepare nanoparticles from *Curcuma longa* L. and *Cosmos caudatus* extracts, and to investigate their physico-chemical characterizations. The first step in this research was maceration extraction of *Curcuma longa* L. and *C. caudatus*, using ethanol (96%), and formulated into nanoparticles. Nanoparticles were characterized using spectrophotometry UV-Vis, FTIR spectrometry, and SEM (scanning electron microscopy). UV-Vis spectra confirmed that formation of nanoparticles emerged in the UV-vis region around 420 nm. FTIR analysis revealed the existence of functional flavonoids compounds from the extracts, showing at wavenumber 1440-1420 cm⁻¹. From SEM analysis, the formation of nanoparticles results in mostly flake-like morphology with particles size found within the range of 15-30 nm. The biologically synthesized nanoparticles could be of immense use in medical field for their potential as anti-cancer drugs.

**Keywords:** *Curcuma longa* L., *Cosmos caudatus*, nanoparticles, SEM, FTIR

1. Introduction

Cancer is the leading cause of death worldwide by donating 7.9 million deaths in the year 2007. Most of the medications for cancer treatment available today have limited potential, because it is toxic, inefficient in treating cancer, or very expensive. Effective method with the use of plant extracts as anti-cancer drug, due plant-based products have natural properties, multi-targeted capabilities, as well as affordable and safe compared with synthetic materials, have been proposed [1-2].

Curcumin is a natural yellow pigment isolated from *Curcuma* herbaceous rhizome which is a mixture of curcuminoids. Curcumin is known to be an antioxidant, anti-inflammatory, anti-fatigue, antiparasitic, anti-allergic, anti-microbial, anti-mutagenic and anticancer. Curcuminoid is a group of phenolic compounds in the rhizome of the family of zingiberaceae, among others: *Curcuma longa* Linn. syn. *Curcuma domestica* Val. (turmeric) and *Curcuma xanthorrhiza* Rox (temulawak) [3]. Curcuminoids are beneficial to prevent the onset of infections of various diseases [4].

Carotenoids are subclasses of phytonutrients that stand out in fruits and vegetables, one of which is *Cosmos caudatus* (kenikir). Lutein in *C. caudatus* is one of the types of xanthophyll with zeaxanthin, it has been a concern to be examined regarding what substances are contained therein [1].

The transmission of nanoparticles is described as a formulation of particles dispersed at the nanometer size or scale per thousand micrometer [5]. The nanoparticles drug should be contained in a drug with adequate quantities in the matrix on each particle grain. Nanoparticles in pharmaceutical
preparations can be systems of drugs in matrices such as nanosphere and nano capsules nano liposomes, nano emulsions, and as a system combined in scaffold and transdermal transmission [6-7].

In this study, the mixture of turmeric extract and kenikir was designed into nanoparticles. The formation of a nanoparticle requires a capping agent and cross-linker agent. Chitosan and TPP (tripolyphosphate) were chosen as capping and cross-linker agents. The nanoparticles, then characterized by Scanning Electron Microscopy (SEM), Fourier Transform Infrared (FTIR), to determine the physical and chemical properties of the nanoparticles produced.

2. Materials and Methods

2.1. Chemicals and instrumentation
The plant specimens of Curcuma domestica L. and Cosmos caudatus were collected from Materia Medica, Batu, East Java. The plant was identified and authenticated by a plant taxonomist of the herbarium unit, UPT Materia Medica, Batu. The fresh parts of this species were washed under running tap water, shade dried at room temperature and crushed into powder. Other materials were purchased from Sigma-Aldrich: ethyl alcohol (pure, d = 0.789 g/mL), glacial acetic acid (pharmaceutical secondary standard), HCl (37%, analytical grade), NaCl (powder, ≥99.5%, analytical grade), FeCl₂·4H₂O (≥99.0%, analytical grade), low-molecular-weight chitosan, and Na-TPP. Water used was demineralized water (Hydrobatt).

Instruments used was UV-Vis spectrophotometer (1601, Shimadzu), FTIR spectrophotometer (Shimadzu FTIR 8400S, sample was analyzed using KBr plate) in the 400-400 cm⁻¹ and Scanning Electron Microscopy (SEM) (FEI, Type: Inspect-S50).

2.2. Extract preparation
Each of the kenikir leaves powder and turmeric rhizome powder were macerated with 96% ethyl alcohol. The solvent was completely removed by rotary evaporator at 80 °C, 120 rpm to obtain concentrated extracts. The extracts were collected in dark glass bottles, and stored at 4 °C for further use. Kenikir extracts and turmeric extracts were each weighed at 200 mg and dissolved in 10 mL of 96% ethyl alcohol. The mixture of kenikir-turmeric extracts in the ratio of 2:1; 1:1, and 2:1 were prepared.

2.3. Nanoparticles preparation
The nanoparticles were prepared from kenikir and turmeric extracts, in the variations of ratio as mentioned above. The mixture of extracts was subsequently dissolved in 35 mL 96% ethyl alcohol, mixed with 15 mL of water, then 100 mL of chitosan solution, then, 1% glacial acetic acid solution was added. A 350 mL of Na-TPP solution was added slowly, accompanied by stirring at a steady speed for 2 h. All the mixture was continued to stir for approximately 2 h at a steady speed. Nanoparticles form mixture of kenikir and turmeric extracts were then separated by centrifugation. Then, the nanoparticles were dried using a spray dryer. The resulting nanoparticles were analyzed using SEM, UV-Vis and FTIR.

2.4. Phytochemical screening
Kenikir and turmeric extracts, and mixture of kenikir and turmeric extracts were subjected to phytochemical screening to determine the presence of active secondary metabolites using standard procedures, for detection of terpenoids, steroids, flavonoids, phenolic compounds, and tannins [8-10].

3. Results and Discussion
The phytochemical test aims to determine secondary metabolite compounds contained in the turmeric and kenikir extracts, and mixture of those extracts. Based on Table 1, the kenikir extracts contains flavonoids, terpenoids and steroids; while the turmeric extract contains phenolics, tannins and flavonoids. These results were in agreement with the literatures indicating that kenikir contains terpenoids compounds and steroids, whereas turmeric contains phenolic groups and tannins [11-12].
Table 1. Phytochemical screening results of *kenikir* leaves extracts, turmeric extracts, and mixture of *kenikir* and turmeric extracts.

| Phytochemical          | *kenikir* Extract | Turmeric Extract | Mixture of *kenikir* and Turmeric Extracts |
|------------------------|-------------------|------------------|--------------------------------------------|
|                        |                   |                  | 2:1                                        |
|                        |                   |                  | 1:1                                        |
|                        |                   |                  | 1:2                                        |
| Flavanoid              | v                 | v                | v                                          |
| Steroid                | v                 | -                | v                                          |
| Terpenoid              | v                 | -                | v                                          |
| Phenolic               | -                 | v                | v                                          |
| Tannin                 | -                 | v                | v                                          |

- = undetected; v = detected

All samples were measured their absorbance at a wavelength range of 200-800 nm. The UV-Vis spectra for the *kenikir* and turmeric extracts, also the mixture of turmeric and *kenikir* extracts is presented in Figure 1. Based on Figure 1, the maximum wavelength for all samples show the same numbers, at around 420 nm. This is categorized as visible light, and at around 420-430 nm light renders a substance yellow, as shown in all sample solutions that have yellow colour. Interestingly, the absorbance of each sample in this wavelength are different. The *kenikir* extract shows highest absorption at 0.420, the turmeric extract has the lowest absorption at 0.145. The mixture of extracts, however, still indicating that the mixture retains their extract properties. For example, *kenikir* and turmeric extract in 2:1 ratio has the maximum absorption closed to *kenikir* extract only; while *kenikir*:turmeric extract in 1:2 shows maximum absorption that close to turmeric extract only. The 1:1 mixture of extract displays maximum absorption of 0.213, this is in between the maximum absorption of *kenikir* and turmeric extract only.

![Figure 1](https://example.com/figure1.png)

**Figure 1.** UV-Vis spectra of *kenikir* and turmeric extracts, and mixture of turmeric and *kenikir* extracts on different ratios.

Results of FTIR spectra of *kenikir* and turmeric extracts, and mixture of those extracts can be seen in Figure 2, and peak assignments are presented in Table 2. In turmeric extract only, there were functional groups of alcohol, alkane, alkenes and aromatics; in turmeric and *kenikir* mixture there were similar functional groups, nonetheless, in *kenikir* extract, there was indication of group of terpenes. It can be seen that the mixture of *kenikir* and turmeric extracts showing more intense of FTIR spectra. The broad and intense absorption peak at around 3500-3400 cm\(^{-1}\), corresponds to the O-H stretching vibrations of polyphenolic compounds. Peaks in region 5 (1430-1450 cm\(^{-1}\)), also correspond to organic, aromatic compounds, and derivations of these compounds including polyphenols, alcohol or terpenoids,
Another peak is observed in region no 10 within the range of 980–960 cm\(^{-1}\), in accordance with C-H bending from aromatic compounds, and/or alkenes.

![FTIR spectra of kenikir and turmeric extract, and mixture of turmeric and kenikir extracts on different ratios.](image)

**Figure 2.** FTIR spectra of kenikir and turmeric extract, and mixture of turmeric and kenikir extracts on different ratios.

**Table 2.** Interpretation of FTIR spectra of kenikir and turmeric extract, and mixture of turmeric and kenikir extracts on different ratios.

| Label | Wavenumber (cm\(^{-1}\)) | Assignment | Compound indicated                      |
|-------|---------------------------|------------|-----------------------------------------|
| 1     | 3500-3400                 | -OH stretching | polyphenols                             |
| 2     | 2960-2850                 | -C-H stretching | aromatics                               |
| 3     | 1680-1670                 | -C=C stretching | alkenes                                 |
| 4     | 1560-1590                 | -C-C bending | aromatics ring                          |
| 5     | 1430-1450                 | -CH\(_3\) bending | alkenes                                 |
| 6     | 1350-1330                 | -C-H stretching | alkanes, alcohol, carboxylic acid       |
| 7     | 1250-1230                 | -C-O- stretching | carbonyl                                |
| 8     | 1150-1090                 | -C-O-C- bending | alcohol                                 |
| 9     | 1090-1080                 | -C-O-C- asymmetrical stretching | carbonyl, alkenyl                      |
| 10    | 980-960                   | -C-H bending | alkenes, aromatics ring                |
The morphology of turmeric, *kenikir* extracts, and mixture of *kenikir* and turmeric extracts are presented in Figure 3. From Figure 3, the resulting images of turmeric and *kenikir* extracts only were rough and uneven, with some irregular and large sheet shapes (Figures 3a and 3b). The mixture of *kenikir* and turmeric extract showed that the nanoparticles retained the original extract surface shapes. The morphology of nanoparticles from 2:1 variation (Figure 3c) was more dominant and there are grainshape attached to the sheet. In the variation of 1:1, composition of the nanoparticles of the sheet and granules look more balanced, thus, the grain attached to the sheet looks more solid (Figure 3d). As in Figure 3e, the morphology of nanoparticles was also similar to that in Figure 3a. Overall, the SEM images of the resulted nanoparticles of *kenikir* and turmeric extracts indicated that the nanoparticles were not optimally formed. This may cause by the process of freeze dry in test samples and coating process in nanoparticles synthesis that was not ideal.

![Image](https://via.placeholder.com/150)

**Figure 3.** SEM images of the: (a) *kenikir* extract; (b) turmeric extract; (c) *kenikir*:turmeric extract in 2:1 ratio; (d) *kenikir*:turmeric extract in 1:1 ratio; and (e) *kenikir*:turmeric extract in 1:2 ratio, magnification was 10,000×.

### 4. Conclusion

Results from this study have shown nanoparticles of mixed *kenikir*:turmeric contains antioxidant, anti-inflammatory, anti-microbial, anti-mutagenic and anticancer compounds. In this study, three variations of the composition of ethanol extract between kenikir and turmeric extract were made by making comparisons of 2:1, 1:1 and 1:2. After characterization, results that the mixing of two plant extracts of *kenikir* and turmeric is able to produce better physical characteristics, compared to *kenikir* or turmeric extract alone.

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