



Preparation and Characterization of Shoe Polish from Cactus (*Opuntia Ficus Indica*) Powder and Charcoal Powder

Tessema Derbe¹(✉), Tassew Alemayehu², and Dinku Senbeta³

¹ Department of Chemistry, Wachemo University, P.O. Box: 677, Hossana, Ethiopia

² Department of Chemistry, Adigrat University, P.O. Box 50, Adigrat, Ethiopia

³ Department of Biology, Adigrat University, P.O. Box 50, Adigrat, Ethiopia

Abstract. Shoe polish is a type of waxy paste that used in gloss, rub resistance, fading resistance and dust resistance by providing a thin film on the surfactants of the shoe. In this research work, new shoe polish was prepared from 5-g cactus powder and 5-g charcoal powder in 75:25 mL wax to olive oil ratio in the presence of denatured alcohol and benzene at an optimized procedure. Furthermore, the prepared shoe polish was subjected to different quality analysis parameters such as viscosity, density, melting point, reflexive index, pH value, ash content, conductivity and moisture content with the comparison of purchased shoe polish (Kiwi). As the results of these tested parameters indicated, the prepared shoe polish has shown a comparable result with purchased shoe polish (Kiwi). The functional group of the prepared shoe polish was also identified using FTIR analysis and the FTIR peaks confirmed the presence of a long-chain ester group in the shoe polish. Besides, the practical use of the prepared shoe polish and purchased shoe polish were examined by polishing some selected leather shoes with these shoe polishes; the prepared shoe polish exhibited a very good gloss, dust adsorption resistance, fading resistance and rub resistance just after three wearing days. Thus, the prepared shoe polish is fulfilled the quality parameters and replaceable the commercially available shoe polish on the market.

Keywords: Bee wax · Cactus · Kiwi · Olive oil · Shoe

1 Introduction

Shoe polish could be either liquid or paste which is used to restore the original luster and smoothness of the polished surface [1, 2]. It cleans and prevents deteriorating as well as fading of the polished surface due to the presence of surface tension forces between shoe surface and applied polish [3]. It used to shine waterproof, restore the appearance of leather footwear and keep the shoes looking new [4, 5]. Shoe polish not only used for footwear but also applied to all leather materials such as handbags, carpets, leather jackets, belts, and others to clean, protect and shine the adsorbents [2, 6].

Shoe polish shows many unique properties [7]. It forms a basis for decorative and protective properties on polished shoe by forming gloss [8]. It prevents precipitation

of dust particles on the surface of polished shoe through quick-drying [9]. It serves as a barrier between polished surface and moisture-filled environment through formation of thin-layer. The polish must look smart and nice after polishing has applied on the adsorbents by forming decorative [2, 3].

Inline the above unique properties of shoe polish, polishing of the shoes daily is necessary for overall grooming. Furthermore, researchers and psychologists had proved that a person who polishes his/her shoes feels happy, confident, encouraged and cheerful. On the other hand, a person who didn't polish his/her shoes well feels defensive, guilty, withered and shy. In this regard, most people have tried to polish their shoes using soap and pure water. Nonetheless, this activity is not advisable since it evaporated very fast and the shine disappeared within a short time. This handy shine is not good for shoes since low wax content of soap and pure water polishes do not nourish durability for the shoe rather it damages at all [2, 6].

Based on the above circumstance facing in, researchers synthesized and characterized the shoe polishes using chemical sources [2, 6, 10]. Nevertheless, synthetic shoe polishes contain toxic colorant agents like aniline that causes sores, neurological retards, allergic reactions and cancer [2, 6]. Hence, replacing of this toxic chemical via environmentally friendly and nontoxic natural ingredient like cactus powder is too crucial. Therefore, this research was designed to prepare and characterize shoe polish from Cactus (*Opuntia Ficus indica*) powder and charcoal powder.

2 Methodology

2.1 Chemicals and Solvents

Cactus powder, stearic acid, benzene, isopropanol, house- Made ethanol (known as 'areke' in Amharic language), olive oil, bee wax, charcoal powder, and paraffin wax were used during the entire work.

2.2 Sampling Method

Mature fresh leaves of cactus (*Opuntia Ficus indica*) were collected from the side of Adigrat city. The collected leaves were washed with water and were put in clean polyethylene plastic bags. The bee wax sample was purchased from Diemma Honey and Bee Development Privet Factory at Adigrat city. The paraffin wax was obtained from Adigrat electronic supermarket. The charcoal was also purchased from the Meda Agame market, Adigrat city.

2.3 Preparation of Wax

The collected 15-g of paraffin wax was melted with stearic acid at high temperature to give a fine solution. 10 mL of white spirit was added and stirred for 15 min. The mixture was allowed to cool and was poured into a container for storage. In another way, the purchased bee wax was weighted and sliced into smaller parts using a knife. 10-g of sliced bee wax was added into double boiling water and waited till the wax was melted completely. A few drops of olive oils were added to prevent the re-solidification of the melted wax; finally stored for preparation of shoe polish.

2.4 Preparation of Shoe Polish

The first step in the preparation of shoe polish is melting of wax with the highest melting point in an electric heater (70 °C). Following this, 75 mL of the melted wax and 25 mL of olive oil were added into the reactor. Into this, five gram of cactus powder was added. The mixture was heated around 80 °C with continuously stirring. Into this heated emulsion mixture, 5–10 mL distilled water was added and the mixture was heated around 85 °C. Five gram of charcoal powder was added into the reactor by continually stirring and heated for half an hour. The mixed mass was poured into the shoe polish containers (Cans). In each cans, a few drops of odour agent (benzene) were added. And then a few drops of denature alcohol alternatively 'Areke' was added to prevent pathogens. The polish was allowed to stay undisturbed for a night and was stored for further analysis.

As shown in Fig. 1, new shoe polish was prepared from environmental available resources mainly cactus powder alternatively cactus jell (moisturizing agent), charcoal powder (colorant agent), waxes (adhesive agents) in the presence of smelling agent (benzene) and denatured alcohol (anti-pathogens and drying agent).

2.5 Instruments and Equipment

Double boiling reactor, hydrometer, Fourier Transform-Infrared Spectroscopy (FTIR) (model: IR prestige 21), Blenders, Preservers, Cans, Viscometer, pH meter (model: APF/Qcto/025), Conductivity meter (Model: Seven compact 5230), Refractometer (model: DR6200/02), Precision Balance (model: Cap124s), Vacuum Oven (model: Ov Ao31xx35), Muffle Furnace (model: P330MB2) were used throughout this work.

2.6 Quality Analysis of Shoe Polish

Most of the quality analysis and characterization of the prepared shoe polish were conducted at Addis's pharmaceutical factory PLC at Adigrat; northern Ethiopia.

pH Value

By taking 20 mL of dissolved prepared and purchased shoe polishes, the acidity or alkalinity was determined using a digital pH meter (model APF/Qcto/025) [11, 12].

Melting Point

The prepared shoe polish was loaded into the sealed melting point apparatus [13]. And the sample was heated and the temperature range was recorded from the initial phase change to final complete phase changes. And then the average result was taken.

Density

The density of the prepared shoe as well as the purchased shoe polish (Kiwi) were determined using a hydrometer.

Moisture Contents

The moisture content of the prepared shoe polish and the purchased shoe polish (Kiwi)

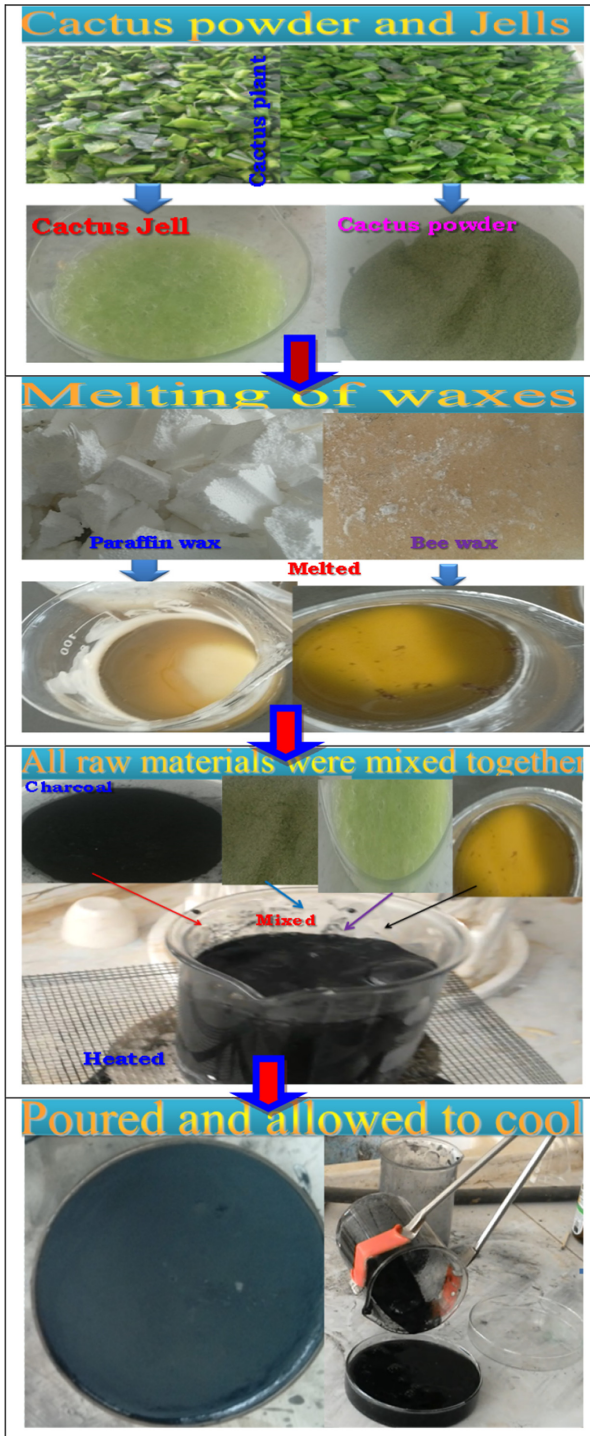


Fig. 1. Steps of shoe polish preparation

were determined using a vacuum oven (model: Ov Ao31xx35) and the percentage of moisture content was calculated by using equation [14, 15].

$$\text{Moister} = \frac{W_3 - W_1}{W_2 - W_3} \times 100\% \quad (1)$$

Where W_3 = weight of sample and watch glass; W_1 = weight of the sample after drying and W_2 = weight of the sample before drying.

Ash Content

The ash content of both prepared shoe polish and the purchased shoe polish (Kiwi) were determined using the Muffle furnace (model: P330MB2) [15]. 1g of both the prepared and the purchased shoe polishes were weighted using precision balance (model: Cap124s). The sample was put into 2 g crucible and the crucible was ignited in the muffle furnace for 3 h and then the crucible was placed in the desiccators. Finally, the sample was cooled to room temperature and weighed. The percentage of moisture content (Ash) was calculated using the equation [16, 17].

$$(\%Ash = 100\% - \%Loss\ of\ ignition) \quad (2)$$

$$\%Loss\ of\ Ignition = \frac{W_3 - W_2}{W_2 - W_3} \times 100\% \quad (3)$$

Where W_3 = weight of the sample after drying; W_2 = weight of sample and crucible and W_1 = weight of a sample after drying.

Viscosity Test

Both the purchased shoe (Kiwi) and the prepared shoe polishes were dissolved by isopropanol in a separate beaker. 5 mL dissolved solution was taken and the viscosity was determined in a standard jacketed pipette viscometer in the unit of poise [12]. The instrument was equipped to hold the shoe polish solution at an approximately constant temperature. The temperature of the shoe polish was 25 °C and the determination was made as soon as the solution has uniformly reached the required temperature.

3 Result and Discussion

3.1 Quality Analysis of Shoe Polish

The prepared shoe polish was subjected to different quality analysis parameters such as viscosity, density, melting point, reflexive index, pH value, ash content, conductivity and moisture content. The analyzed parameters were compared with purchased shoe polish (kiwi) that purchased from the supermarket as shown below (Fig. 2 and Table 1).

pH Value

The pH value of both the prepared shoe polish (sample) and the purchased shoe polish (Kiwi) were measured using a digital pH meter (model APF/Qcto/025) with standard method [13]. As shown in Figure 2 and Table 1, the prepared shoe polish has a pH value

of 4.46 ± 0.43 which is relatively basic than purchased shoe polish (Kiwi) which has 4.25 ± 0.50 pH value. This indicates that the prepared shoe polish is less scratching the polished shoes or any other absorbent surfaces than the purchased shoe polish (Kiwi); the acidic adsorbate highly affect the durability and shining of the shoe surface.

Melting Point

The melting point of the prepared shoe polish and purchased shoe polish (Kiwi) was measured using a thermometer. The melting points of the prepared shoe polish shows 45–48 °C which is ranged. This ranged melting point indicates the presence of different constituents in the prepared shoe polish such as bee wax, cactus powder, olive oil, denatured alcohol, and charcoal powder. Similarly, the purchased shoe polish (Kiwi) shows 42–45 °C which is not sharp. Both the prepared and the purchased shoe polishes show variable melting points; this might be the presence of different constituents in the shoe polishes.

Viscosity

The viscosity was determined in a purchased jacketed pipette viscometer in the absolute unit of “centipoise (CP)”. This method is commonly referred to as the Brookfield method [13, 18] and is described in ASTM D2983. The viscosity of this prepared shoe polish was 3.87 ± 0.09 which is comparable with purchased (Kiwi) 3.15 ± 0.37 at 25 °C as shown in Fig. 2 and Table 1. The flow of the prepared and purchased shoe polishes is almost similar and corresponds to each other.

Moisture Content

The moisture content of the prepared shoe polish and the purchased shoe polish (Kiwi) were evaluated using a vacuum oven (model: Ov Ao31xx35). As it has seen in Fig. 2 and Table 1, the moisture content of prepared shoe polish is $58.24\% \pm 0.23$ which is less moisturized than the purchased shoe polish (Kiwi) $69.38\% \pm 0.82$. This might be due to the presence absorbent nature of charcoal powder which cases strong hydration in the prepared shoe polish. The other provable reasons might be due to drying time; uneven drying and over-drying of the prepared shoe polish in the drying oven [15].

Ash Content

The ash content of the prepared shoe polish and the purchased shoe polish (Kiwi) were determined using Muffle furnace (model: P330MB2) as stated in the method section. The percentage ash content of the prepared shoe polish is $1.1\% \pm 0.11$ while the purchased shoe polish (Kiwi) is $0.3\% \pm 0.05$ (Fig. 2 and Table 1). As the result revealed that the prepared shoe polish contains a relatively large number of inorganic constituents than the purchased shoe polish (Kiwi). This might be due to the presence of porous charcoal powder.in prepared shoe polish; this leads high inorganic residue during ignition.

Refractive Index

The reflexive indexes of both the prepared and the purchased shoe polishes were analyzed using the Refractometer (model: DR6200/02). As the results revealed that 1.37692 ± 0.20 for purchased shoe polish (Wiki) and 1.37687 ± 0.03 for the prepared

shoe polish which is almost equivalent (Fig. 2 and Table 1). Thus, they are comparable in the shining and attractiveness on the shoe after polishing has applied.

The parameters analyzed above can affecting the quality of shoe polishes. Shoe polishes having high moisture content, high reflexive index, and less conductive are more acceptable and shining as well as water repellent. This leads to quick dryable and dust repellent after polishing has been applied on the shoe surface [6, 4].

Table 1. Comparisons of prepared shoe polish with purchased shoe polish (Kiwi)

| Parameters | Purchased (Kiwi) | Prepared |
|---------------------------|--------------------|--------------------|
| pH | 4.25 ± 0.50 | 4.46 ± 0.43 |
| Density (g/mL) | $0.67 \pm .094$ | 0.84 ± 0.067 |
| Viscosity (cp) | 3.15 ± 0.37 | 3.87 ± 0.09 |
| Melting point (°C) | 42 ± 0.23 | 48 ± 0.56 |
| Moisture content (%) | 69.38 ± 0.82 | 58.24 ± 0.23 |
| Reflexive index | 1.37692 ± 0.20 | 1.37687 ± 0.03 |
| Conductivity(μ S/cm) | 0.443 ± 0.11 | 0.623 ± 0.10 |
| Ash content (%) | 0.3 ± 0.05 | 1.1 ± 0.11 |

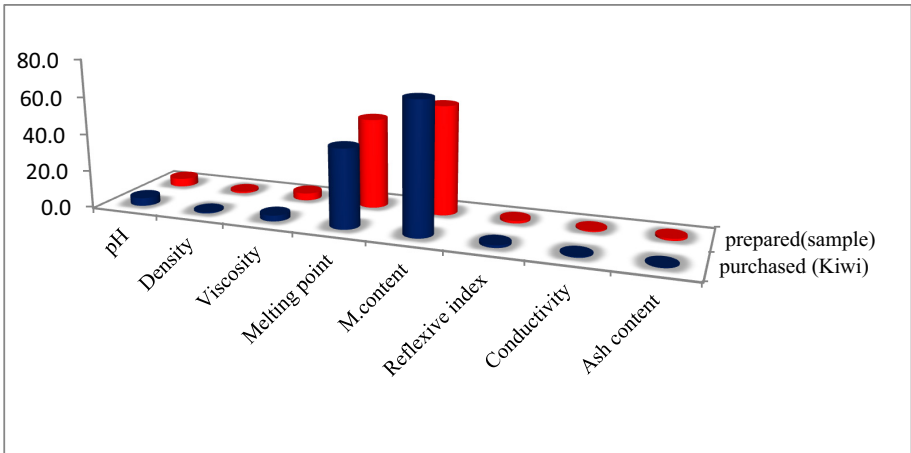


Fig. 2. Results from quality analysis

Practical Test of Shoe Polish

By considering the comparable results that had obtained above, some shoes have polished via prepared shoe polish and purchased shoe polish, and then some practical tests of the polished shoe such as rub resistance [6], fading resistance [2], and dust adsorption resistance were tested just after three days wearing time. The level of dust adsorption

resistance was examined by simple observation and compared with the purchased shoe polish (Kiwi). The polished shoe was also rubbed with glass paper to test the rub resistance; the change was examined and compared with the purchased shoe polish. The polished shoe was also tested for fading resistance by exposing it to the sun for 24 h and the change is observed (Table 2).

Table 2. Some practical use of shoe polishes

| Tests | Prepared shoe polish | Purchased shoe polish |
|-------------------|----------------------|-----------------------|
| Drying time | Moderate | Very good |
| Rub resistance | Very good | Moderate |
| Fading resistance | Very good | Very good |
| Gloss/shining | Very good | Very good |

The prepared shoe polish exhibited a very good gloss, dust absorption resistance, fading resistance and rub resistance on the applied leather shoes as shown below Fig. 3 in fact, the prepared shoe polish can be also applied to all leather materials such as handbags, carpets, belts, wallets and related surface adsorbents.



Fig. 3. Practical test of shoe polish

3.2 FTIR Spectroscopy Analysis

Purchased Shoe Polish (Kiwi)

As shown in Fig. 4, the peak at 2952.02 cm^{-1} indicates the presence of alkyl C-H stretching since most absorption peaks of C-H single bonds occur in the range of $2960\text{--}2850\text{ cm}^{-1}$ [19]. The peak at 1735.93 cm^{-1} indicates the presence of carbon-oxygen double bonds which is a carbonyl group (C = O stretching) [18]. The sharp peaks at 1371.17 cm^{-1} and 1462.04 cm^{-1} indicate the presence of =C-H stretch since the most =C-H absorptions [18] occur in the range of $1480\text{--}1350\text{ cm}^{-1}$. The peak at 1170.79 cm^{-1} indicates the presence of C-O stretching; the most carbon to oxygen single bonds (C-O) absorption occurs in the range of $1300\text{--}1000\text{ cm}^{-1}$ [19]. Thus, the FTIR absorption peaks and analysis possibly confirm the presence of the ester group in the purchased shoe polish Kiwi (Fig. 4).

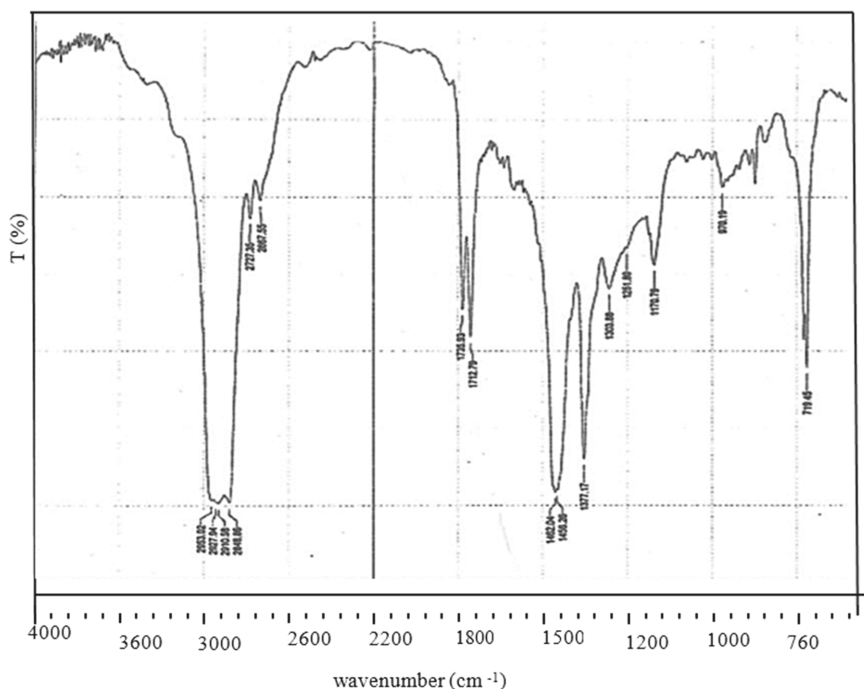


Fig. 4. FTIR analysis of purchased shoe polish (Kiwi)

Prepared Shoe Polish (Sample)

As shown in Fig. 5 below, the peak at 2953.02 cm^{-1} indicates the presence of alkyl C-H stretching since $2960\text{--}2850\text{ cm}^{-1}$ is the most absorption range for C-H single bonds stretching [18]. The peak at 1749.44 cm^{-1} indicates the presence of a carbonyl group (C = O stretch). A sharp peak at 1448.54 cm^{-1} indicates the presence of =C-H bending

since the most =C-H absorption [19] occurs in the range of 1480–1350 cm^{-1} . The peak at 1170 cm^{-1} also indicates the presence of C-O stretch; the most C-O absorption occurs in the range of 1300–1000 cm^{-1} [19]. Thus, the FTIR absorption peaks and analysis confirms the presence of a long chain aliphatic ester group in the prepared shoe polish (Fig. 5). This might be due to the presence of bee wax which has a long chain of alcohols; it is a secondary alcohol which can be dehydrogenated to ketone or carboxylic groups and further to ester groups during preparation of this shoe polish from bee wax and cactus powder as listed in methodology section [5, 9]. The presence of ester group in this prepared shoe polish being serving an additive in terms of lubrication and resistance of hydrolysis [8, 9]. Furthermore, the presence of ester group in shoe polish plays an important role in quick-drying and good smell during and after polishing of the shoe.

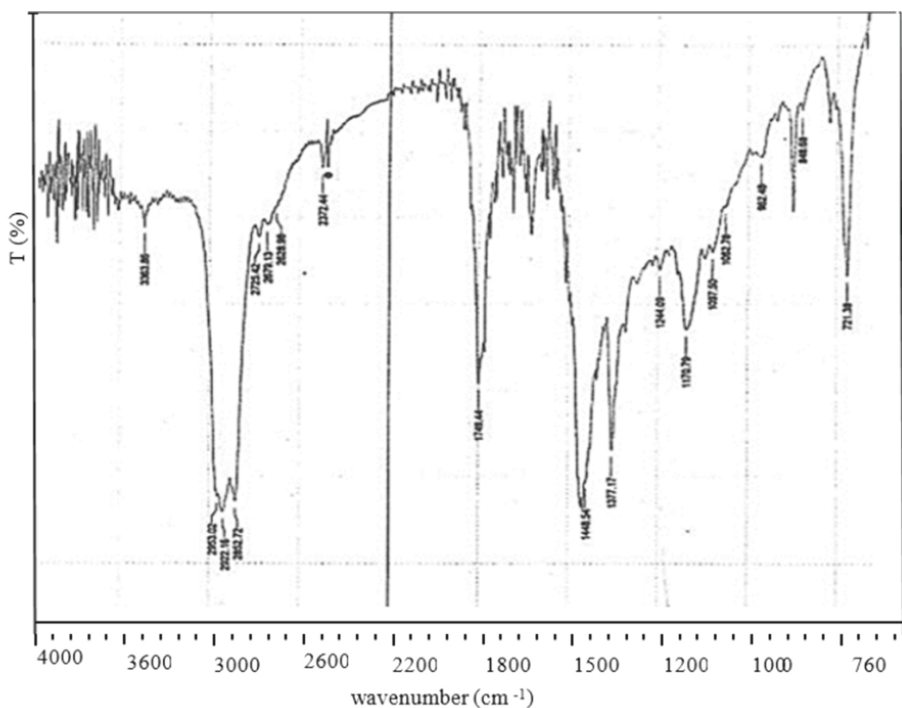


Fig. 5. FTIR analysis of prepared shoe polish (sample)

4 Conclusion

In conclusion, the shoe polish was prepared from cactus powder and charcoal powder in the presence of bee wax and olive oils at small scale. The prepared shoe polish was tested with different quality parameters such as viscosity, density, melting point, reflexive index, pH value, ash content, conductivity and moisture content, and compared with purchased shoe polish (Kiwi). The tested parameters indicated that the prepared

shoe polish is comparable with purchased shoe polish (Wiki). The functional group of both the prepared and purchased shoe polishes were identified using FTIR analysis and the peaks confirmed that the presence of long chain ester groups in both prepared and purchased shoe polishes. Furthermore, the practical use of prepared shoes polish and purchased shoe polish (Kiwi) such as rub resistance, fade resistance, dust adsorption, and drying time were tested through polishing of some selected leather shoes; resulted in the prepared shoe polish is very good and analogous with the purchased shoe polish (Kiwi). Thus, the work suggests the stakeholders to prepare and to use this shoe polish since it meets all the tested quality parameters and practical parameters in the comparison of well-known shoe polish (Kiwi). Moreover, the prepared shoe polish is low cost and eco-friendly which can replace the market available shoe polishes and create a new promising job opportunity for the community.

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Competing of Interests. The authors declare that they have no competing of interests.

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