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Research Article

EXPLORING NATURAL REMEDIES FOR FOOT INFECTIONS: A STUDY ON LIFESTYLE CHANGES AND ALTERNATIVE TREATMENTS FOR CORNS – A POLYHERBAL FORMULATION

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ABSTRACT

Foot corns and calluses are common hyperkeratotic conditions that develop due to repeated friction and pressure, resulting in pain, discomfort, and difficulty in movement. The present research involves the development and assessment of a polyherbal gel prepared using hydroalcoholic extracts of Curcuma longa, Zingiber officinale, Allium cepa, Allium sativum, and Citrus limon, blended with an aloe vera gel base. The extracts were prepared using maceration and incorporated into three formulations (F1, F2, and F3). These formulations were assessed for their physicochemical attributes, including colour, pH, viscosity, spreadability, solubility, washability, skin compatibility, and stability. Phytochemical screening confirmed the presence of major constituents, including alkaloids, flavonoids, proteins, carbohydrates, glycosides, and amino acids. In vitro antimicrobial studies demonstrated that all formulations displayed inhibitory activity against Staphylococcus aureus and Candida albicans, with F3 showing the highest zone of inhibition. Overall, the polyherbal gel demonstrated desirable physical characteristics, good safety, and strong antimicrobial potential, indicating its usefulness as a natural topical treatment for foot corns.

Keywords: Polyherbal gel, Foot corns, Anti-microbial activity, Herbal extract, *Aloe vera*.

INTRODUCTION

Corns contain a central core that may become painful when it presses against a nerve. They develop as a result of continuous pressure or friction over bony areas, such as joints (West Wessex Podiatry, 2025). They are most commonly observed on the fingers of the hands and more frequently beneath the feet and toes. Corns and calluses are thick, hardened layers of skin that form as a protective response to repeated pressure and friction. Individuals with diabetes or conditions that impair blood circulation to the feet have a higher risk of developing these lesions. Typically, corns and calluses diminish once the underlying source of pressure or friction is eliminated (Dixit S, 2019). It is difficult to distinguish between different kinds of keratotic lesions in many medical textbooks. Furthermore, rheumatologists, dermatologists, podiatrists, and American and British surgeons used diverse and somewhat confusing terminology. The following definitions of the terms represent their most common usage (Singh D, 1996). Corns' conical core serves as a defence mechanism against mechanical stress. The corn and callus are separated by their central core. Corn arises in response to pressure and friction, just like a callus. Unlike a callus, a corn lacks papillary ridges, and its surface becomes smoothly burnished as the skin reacts to pinpoint pressure over a bony prominence by rapidly accelerating cell production. Consequently, layers of immature cells accumulate, which do not mature into the fully developed, protective dead skin layer characteristic of a callus. The term *heloma* is also used to describe a corn. Five subtypes of corns are recognised, all of which become tender when direct pressure is applied. These include the hard corn (*heloma durum*), the soft corn (*heloma molle*), the vascular corn (*heloma vasculare*), the fibrous corn (*heloma fascia*), and the seed corn (*heloma milliare*). (Grouios G, 2004). Repetitive pressure and friction from ongoing movements contribute to the formation and enlargement of corns and

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calluses. Several factors that generate this pressure and friction include:

Certain areas of the foot may become compressed by tight shoes and high heels. A foot that fits too loosely in a shoe may rub against internal seams or stitching, and may frequently slide or grind against them. If you wear sandals or shoes without socks, your feet may become irritated, thereby causing problems to arise from improperly fitting socks. It may occur due to repeated pressure, like writing, using hand tools, or playing an instrument can cause calluses on your hands. Standing for long periods of time (West Wessex Podiatry, 2025). Excessive pronation of the foot. High arches. Poor range of motion and mobility in joints. Previous trauma or surgery. Bony prominences like Bunions or Rheumatoid arthritis (West Wessex Podiatry, 2025, Dixit S, 2019). A thickened, roughened patch of skin, Pain under the skin or tenderness. Flaky, waxy or dry skin. They can be painful due to a hard centre near the corn. Sometimes it may bleed (Dixit S, 2019).

Corns have a painful central core caused by pressure or friction over bony areas, commonly on fingers, feet, and toes. They, along with calluses, are thickened skin layers formed as a defence against friction. These are more common in people with diabetes or poor foot circulation. Removing the source of pressure usually helps them fade. These are 5 types (West Wessex Podiatry, 2025, Dixit S, 2019, Singh D, 1996, Freeman, D. B. 2002, Kumar A Grouios G. 2004). Hard corns are the most frequently occurring type of dry, hardened skin growths characterised by a tough central core, usually developing on or near the toes and the sole of the foot as a result of repeated friction or pressure (Singh D, 1996, Freeman D. B, 2002, Kumar, A Grouios G, 2004).

Soft corns are painful, softened skin lesions that typically develop between the toes, most frequently between the fourth and fifth, due to retained moisture. They usually appear grayish-white and have a moist, macerated texture. (Singh D, 1996, Freeman D. B, 2002, Kumar A Grouios G, 2004). Seed corns are small, generally painless lesions with a central core that gradually develop on the balls of the feet and the tips of the toes. They are commonly observed in individuals with either very dry or excessively sweaty feet, as well as those who do not wear shoes consistently (West Wessex Podiatry, 2025, Grouios G, 2004). Vascular corns are also known as heloma vascular, and these corns comprise both nerve fibres and blood vessels. Vascular corns are extremely painful, frequently become inflamed and bleed heavily if they are cut (West Wessex Podiatry, 2025, Grouios G, 2004). Fibrous corns, also referred to as *heloma fascia*, develop from long-standing, untreated chronic corns. They become more firmly anchored to the deeper tissues than other types, gradually growing inward and embedding themselves further into the foot. As a result, they appear more fibrous in texture and are typically quite painful (West Wessex Podiatry, 2025, Grouios G, 2004).

Figure 1. Types of Foot corns.

A callus is a thickened patch of skin that forms in response to repeated pressure or friction, most commonly beneath the ball of the foot. Unlike corns, calluses cover a broader surface area, do not possess a central core, and are often not painful. They are also referred to by various names, including keratoma and tyloma. The main types include: 1. Localised callus or Discrete nucleated callus. 2.Diffuse callus or Diffuse -shearing callus. A plantar corn, also known as a discrete nucleated callus or focal intractable plantar keratosis, is a small, painful spot with a hard centre that forms in high-pressure areas on the foot. Its central toughened core causes discomfort and can be mistaken for a wart, unlike broader, less painful calluses. A diffuse shearing callus is a lesion that is more than 1 cm across and is caused by a misaligned metatarsal head; it does not have a keratin plug inside. It was referred to as diffuse intractable plantar keratosis by American authors (Singh D, 1996, Freeman D. B, 2002, Kumar A Grouios G, 2004). To avoid your toes rubbing against the shoe or other toes, make sure your shoes are comfortable and fit correctly. In order to avoid bunching under your feet, socks should be worn with shoes. Wearing cushioned gloves is

recommended when handling heavy or rough objects that could cut your hands or fingers. Make use of padded or cushioned insoles; these inserts can balance the weight-bearing pressures on the bottom of the foot. Examine and wash your feet daily with warm or soapy water to promote smooth and soft skin. Trimming of toenails (Dixit S, 2019).

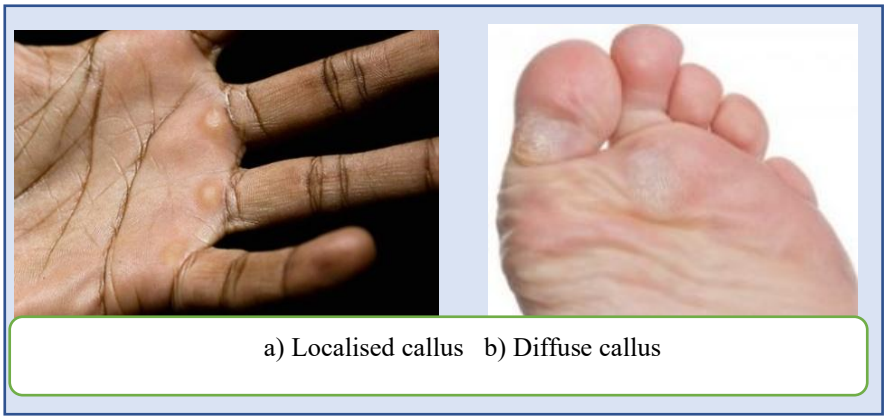
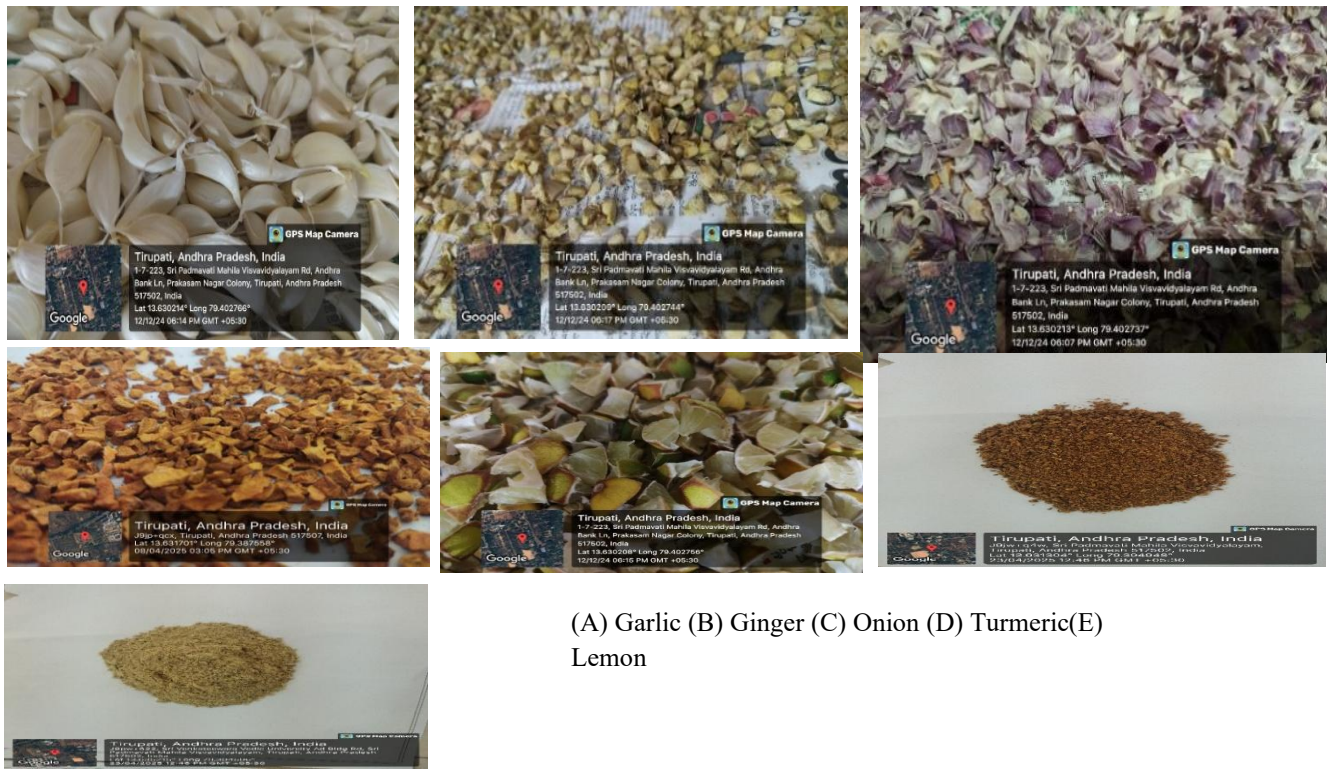


Figure 2. Types of Calluses.

MATERIALS AND METHODS

Procurement of plant materials

Rhizomes of *Curcuma longa* and *Zingiber officinale*, bulbs of *Allium cepa* and *Allium sativum*, and fruits of *Citrus limon* were procured from the local market in Tirupati, Andhra Pradesh, India. All plant materials were collected fresh, thoroughly washed, and subsequently shade-dried. All chemicals used in the study were of analytical grade.



(A) Garlic (B) Ginger (C) Onion (D) Turmeric(E) Lemon

Figure 3. Collection of Plant Materials.

Extraction

The extraction method employed in this study was maceration. Maceration is an extraction technique in which coarsely powdered plant or organic material is soaked in an appropriate solvent (such as water, alcohol, or oil) and allowed to stand at room temperature for a defined duration, with occasional stirring, to facilitate the dissolution and extraction of the desired constituents. In this procedure, 20 g of the polyherbal powder was mixed with 200 ml of 70% ethanol in a 1:10 ratio. The mixture was stored in a tightly closed glass container and kept aside for 24 hours at room temperature. After being subjected to maceration, the extract was first filtered through muslin cloth for coarse filtration, followed by fine filtration using the Whatman filter paper no.1 to obtain a clear hydroalcoholic extract. The resulting macerate was then freeze-dried to remove the solvent and yield the purified extract.

Figure 4. Maceration, Filtration, Freeze Dryer.

Table 1. Maceration of polyherbal powder weights.

Sl. No.	Ingredients	Quantity
1	*Curcuma longa*	6gm
2	*Allium cepa*	4gm
3	*Zingiber officinale*	4gm
4	*Citrus limon*	3gm
5	*Allium sativum*	3gm

Table 2. Formulations.

S. No.	Components	F1	F2	F3
1	Aloe vera gel base	100gm	150gm	200gm
2	Poly herbal extract	0.5gm	1.0gm	1.5gm
3	Vitamin E	0.5ml	0.5ml	0.5ml
4	Perfume	q.s.	q.s.	q.s.

Preparation of Gel: **Dispersion method**

A measured quantity of guar gum, 1.5 g, was added to the aloe vera gel or juice of 95 g already prepared from the aloe vera plant. Now add 3 gm of glycerine to it for hydration and to help with texture. Guar gum acts as a natural gelling agent or stabiliser. After mixing of ingredients, the sample is homogenised to ensure uniform mixing of all the ingredients and stored in a sterile container. Macerated extraction is added with continuous stirring to formulate a herbal gel and stored in a sterile container. Three compositions were prepared into different formulations by various ratios of the excipients (Shuja M, 2023, Sharma U, 2022).

Assessment of polyherbal gel

The physical characteristics of the prepared polyherbal gel including colour, appearance, pH, viscosity, and spreadability-were evaluated. The formulations were also assessed for their antibacterial and antifungal activities.

Appearance

The colour, overall appearance, and homogeneity of the gels were examined visually. Once placed in their containers, each and every formulation was inspected to evaluate its physical characteristics.

pH

To measure pH, disperse 1g of gel in 100ml of distilled water. The pH was determined using pH paper, and the corresponding colour change was compared with the standard colour chart provided by the manufacturer.

Spreadability

Spreadability was assessed by placing 0.5 g of the gel on a glass slide with a 1 cm diameter and covering it with another slide. A 250 g weight was applied for five minutes. The increase in spread diameter was observed, and the time required to separate the slides was recorded. Spreadability was calculated using the formula:

Where:

S = Spreadability

m = Weight applied on the upper slide

L = Distance moved by the slide

T = Time taken to separate the slides (Mukkirwar S. P, 2021, Keshwar A, 2018).

Washability

The washability test was run by applying a minimum quantity of the formulated gel on the skin and rinsing it under the free-flowing water (Mukkirwar S. P, 2021, Raut K. S, 2025).

Viscosity

This rheological property helps assess the consistency of the formulated gel and the rate at which the drug diffuses from it. The viscosity of the prepared formulations was analysed using a Brookfield viscometer. The sample was placed in a beaker and tested using spindle number 62 at rotational speeds of 20 and 30 rpm. Viscosity readings were recorded at each speed (Mukkirwar S. P, 2021, Guleri K. T, 2013).

Solubility

Solubility studies in distilled water and Ethanol,Ether, and chloroform (Stublić K,1886, Jamadar M. J,2017).

Skin- Irritation: The Gel has been applied to human skin, and the results have been monitored. (Mithal B. M, 2010, Stublić K., 1886).

Stability test

To assess the stability of the finished product, the formulation was stored in a stability chamber for three months. Any symptoms of bacterial or fungal growth, and also any observable changes in the formulation's colour, consistency, and odour, are examples of additional physical instabilities. Growths were examined. (Padmanabha V. A, 2017, Soumya A, 2020, Jamadar M. J, 2017).

***In-vitro* Anti-microbial activity**

The test organism, *Staphylococcus aureus*, was inoculated onto Mueller–Hinton Agar plates. Two wells were made in the medium using a sterile borer. Dilutions of each of the three formulations were prepared, and 0.2 ml of each sample was introduced into the respective wells. The plates were then incubated at 37 °C for 24 hours. After incubation, the zones of inhibition obtained by each formulation were measured to evaluate their antimicrobial activity. All tests were performed in triplicate, and the average zone of inhibition was calculated (Padmanabha V. A, 2017, Soumya A, 2020, Kamathe S, 2024).

Antifungal activity

Antifungal activity was evaluated using the disc diffusion method. The test fungus, *Candida albicans*, was inoculated onto agar plates. Wells were then created using a sterile borer. Appropriately diluted formulations in volumes of 75 µl, 50 µl, 25 µl, 10 µl, and 5 µl were dispensed into the wells using a micropipette. The plates were incubated at 37 °C for 18–24 hours. After incubation, the diameter of the inhibition zones was measured in millimetres using a suitable measuring device (Padmanabha V. A, 2017, Soumya A, 2020, Kamathe S, 2024).

Phytochemical Screening

A qualitative phytochemical analysis was performed on the hydroalcoholic extract. Key bioactive plant constituents such as steroids, terpenoids, carotenoids, flavonoids, alkaloids, and tannins play an essential role in rational drug design aimed at developing safer and more effective therapeutics. The following procedures were used to identify the presence of various chemical groups in the extract.

Test for Saponins – Foam Test

A small amount of extract was mixed with a little water in a test tube and shaken vigorously. The formation of persistent foam lasting for 10 minutes indicated the presence of saponins.

Test for Alkaloids – Wagner's Test

To 2–3 ml of the filtrate, a few drops of Wagner's reagent were added. The appearance of a reddish-brown colour confirmed the presence of alkaloids.

Test for Flavonoids – Lead Acetate Test

The test solution was treated with a few drops of 10% lead acetate solution. The formation of a yellow precipitate indicated the presence of flavonoids.

Test for Proteins – Biuret Test

Two millilitres of Biuret reagent were added to 2 ml of the extract, mixed well, and gently heated in a water bath. A red or violet colouration indicated the presence of proteins.

Test for Carbohydrates – Benedict's Test

Equal volumes of Benedict's reagent and the extract were mixed in a test tube and heated in a boiling water bath for 5 minutes. The solution turned green, yellow, or red depending on the amount of reducing sugar present.

Test for Glycosides – Keller–Killiani Test

The test solution was mixed with a few drops of glacial acetic acid containing ferric chloride, followed by the careful addition of concentrated sulfuric acid along the sides of the test tube. The appearance of a reddish-brown lower layer and a bluish-green upper layer confirmed the presence of glycosides.

Test for Amino Acids – Ninhydrin Test

Three millilitres of the extract were heated with three drops of 5% ninhydrin solution in a boiling water bath for 10 minutes. The development of a bluish colour indicated the presence of amino acids (Jamadar M. J, 2017).

RESULTS AND DISCUSSION

Sl. No	Parameter	F1	F2	F3
1	Appearance	Pale yellow colour, Characteristic odour.	Yellow colour, Characteristic odour.	Yellow colour, characteristic odour.
2	pH	6.5	6.5	7.0
3	Spreadability	22.6 (gm.cm/sec)	22.5 (gm.cm/sec)	27.6 (gm.cm/sec)
4	Washability	Easily washable	Easily washable	Easily washable
5	Viscosity	17,940(cp)	20,200(cp)	22,060(cp)
6	Solubility	Soluble in water and Ethanol	Soluble in water and Ethanol	Soluble in water and Ethanol
7	Skin Irritation	There is no irritation on the application, and it is acceptable for skin.	There is no irritation on the application, and it is acceptable for skin.	There is no irritation on the application, and it is acceptable for skin.
8	Stability	Stable in 3 Months No Colour Change, Microbial growth.	Stable in 3 Months No Colour Change, Microbial growth.	Stable in 3 Months No Colour Change, Microbial growth.

Table 4. Phytochemical screening.

Sl. No	Chemical Test	Observation	Inference
1	**Saponins:** Foam test	No foam	–
2	**Alkaloids:** Wagner's test	Reddish brown colour	+
3	**Flavonoids:** Lead acetate test	Yellow ppt	+
4	**Proteins:** Biuret test	Red colour	+
5	**Carbohydrates:** Benedict's test	Red colour	+
6	**Glycosides:** Killer-killani test	Reddish brown colour	+
7	**Amino acids:** Ninhydrin test	Bluish colour	+

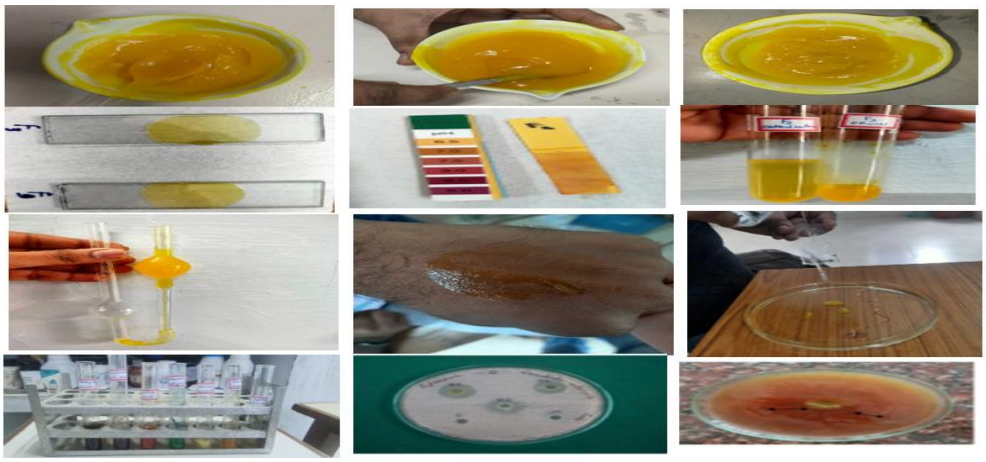


Figure 5. Formulation and evaluation of Foot corn Gel.

All three formulations, each containing different concentrations of the extract, were evaluated for antibacterial activity by comparing the diameters (in mm) of their zones of inhibition. The zone of inhibition produced by a clear region surrounding a well containing an antimicrobial agent serves as an indicator of the formulation's effectiveness, with a larger zone signifying greater antibacterial potency. The ability of the polyherbal gel to inhibit the growth of *Staphylococcus aureus* was assessed, and all three formulations demonstrated measurable antibacterial activity. Among them, formulation F3 showed the largest zone of inhibition, indicating superior activity compared to the other two formulations. The diameters of the inhibition zones, measured in millimetres, were compared during the antifungal activity test. The zone of inhibition, an area devoid of microbial growth surrounding a disk containing the antifungal agent, serves as an indicator of antifungal potency. A larger zone reflects stronger antifungal activity. The ability of the polyherbal gel to inhibit *Candida albicans* was evaluated, and although the results showed a noticeable zone of inhibition, the extent of inhibition was smaller than anticipated.

CONCLUSION

This study aimed to formulate and evaluate a polyherbal gel containing extracts of turmeric, ginger, garlic, onion, and lemon in an aloe vera base for the management of foot corns. The gel demonstrated favourable characteristics, including good spreadability, appropriate viscosity, optimal pH, a non-greasy texture and easy washability, all contributing to user comfort. Stability and irritation assessments further confirmed that the formulation is safe and appropriate for topical use. Among the three formulations, F3 showed the best performance, exhibiting superior physicochemical properties. It also displayed marked antimicrobial activity against Staphylococcus aureus and antifungal activity against *Candida albicans*, producing the largest zone of inhibition. Overall, findings indicate that this polyherbal gel is a promising natural and patient-friendly option for treating foot corns.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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