

Antimicrobial activity of creams formulated with protein and hydromethanolic extracts of germinated shea seeds on *Candida albicans* and *Staphylococcus aureus*

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Abstract :

Shea (*Vitellaria paradoxa*) is a tree of Sapotaceae family that grows exclusively in the wooded savannas in Africa. Its fruit is a drupe consisting of the pulp, which is eaten. The nut consists of the shell and the kernel. Kernel is the element from which the butter shea's is extracted. During processing, germinated shea seeds are rejected because the butter from these germinated nuts would be poor commercial quality. With this in mind, shea butter was evaluated in vitro for its antimicrobial activity in this study. Thus, protein and hydromethanol extracts were prepared from germinated shea seed press cakes. Antimicrobial activity was assessed by evaluating the antimicrobial potential of creams formulated from germinated shea seeds protein and hydromethanol extracts. Creams incorporated with protein and hydromethanol extracts of germinated seeds generally inhibited the growth of *Candida albicans* and *Staphylococcus aureus* to varying degrees. However, creams incorporating 10% hydromethanolic and protein extracts of sprouted seeds showed the best inhibition rates on *Candida albicans* (56.05 and 50.19 %) and *Staphylococcus aureus* (83.33 and 80.88 %). The antimicrobial power of creams based on hydromethanolic and protein extracts of germinated shea seeds on the growth of *Candida albicans* and *Staphylococcus aureus*. Antimicrobial power of creams based on hydromethanolic and protein extracts of germinated shea seeds on the in vitro growth of the pathogenic microbial strains (*Candida albicans* and *Staphylococcus aureus*) tested could make them potential candidates for the development of drugs to treat skin infections caused by these microbes.

Keywords: antimicrobial activity, germinated shea seed, creams, protein and hydromethanolic extracts, *Staphylococcus aureus* and *Candida albicans*.

Activité antimicrobienne de crèmes formulées à base d'extraits protéiques et hydrométhanoliques de graines de karité germées sur *Candida albicans* et *Staphylococcus aureus*

Résumé :

Le karité (*Vitellaria paradoxa*) est un arbre de la famille des Sapotacées qui pousse exclusivement dans les savanes arborées d'Afrique. Son fruit est une drupe constituée de la pulpe qui est consommée, de la noix qui, elle-même est constituée de la coque et de l'amande. L'amande est l'élément à partir duquel, le beurre qui est le principal produit du karité est extrait. Cependant, au cours de cette transformation, les graines germées de karité sont rejetées car le beurre issu de ces noix germées serait de mauvaise qualité commerciale. C'est dans cette optique qu'il a été évalué in vitro pour son activité antimicrobienne. Pour cette étude, des extraits protéiques et hydrométhanoliques ont été préparés à partir des tourteaux de graines germées de karité. L'activité antimicrobienne a été réalisée en évaluant le potentiel antimicrobien de crèmes formulées à partir d'extraits protéiques et hydrométhanoliques de graines germées de karité. Les crèmes incorporées à base d'extraits protéiques et hydrométhanoliques de graines germées ont dans l'ensemble inhibé la croissance de *Candida albicans* et *Staphylococcus aureus* à des taux variables. Mais les crèmes incorporées à 10% d'extraits hydrométhanoliques et protéiques de graines germées révèlent les meilleurs taux d'inhibition sur *Candida albicans* (56,05 et 50,19) et *Staphylococcus aureus* (83,33 et 80,88 %). Le pouvoir antimicrobien des crèmes à base d'extraits hydrométhanoliques et protéiques des graines germées de karité sur la croissance in vitro des souches microbiennes pathogènes (*Candida albicans* et *Staphylococcus aureus*) testées fait de celles-ci des candidats potentiels pour le développement de médicaments pour le traitement des infections cutanées.

Mots-clés : activité antimicrobienne, graines de karité germées, crème, extraits protéiques et hydrométhanoliques, *Staphylococcus aureus* et *Candida albicans*.

Introduction

Shea tree (*Vitellaria paradoxa*) belong to Sapotaceae family; it exclusively grows savanna areas in Africa (Yé et al., 2007). Local interest of this tree lies in the fact that all its parts can be exploited such as roots, leaves, wood, bark, flowers, etc. Its fruit is a drupe consisting in the pulp, which is consumed and in the nut. The nut consists of the shell and the kernel. Kernel matrix of shea butter is the most valorized part of the tree (Bonkougou, 1987; Pesquet, 1993; Hall et al.,

1996). Indeed, shea butter is highly exploited for various purposes (food, cosmetics and pharmaceutical), (Kouyaté et al., 2015). Shea butter is so important that several standards were set up in order to approve its quality. Hence for instance, some authors recommended to avoid using germinated nuts in shea butter processing because resulting butter would be poor commercial quality. Whereas on biochemical point of view, seeds germination would involve

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macromolecules degradation into new useful molecules (Baskin et Baskin 2001) which biological activities. Hence germination process would transform or convert germinated seeds into a real source of health beneficial molecules. As a result, more and more studies are focusing on germinated seeds for use in a number of fields, including food, cosmetics and pharmaceuticals. This is the case for barley, sesame and soybean germinated seeds, which have been used to make beer and infant flour respectively (Kouamé, 2019). In addition, studies have shown that germinated shea seeds contain bioactive molecules such as polyphenols (flavonoids and tannins), terpenoids and proteins/peptides (Djoman 2023).

1. MATERIAL AND METHODS

1.1. Biological material

Plant material used in this study consisted of germinated shea seeds supplied by the Pedagogical and Research Unit in Food Biotechnology of the University Felix HOUPHOUET BOIGNY. Fungal mushroom (*Candida albicans*) and bacterial (*Staphylococcus aureus*) strains causing skin infections were used for antimicrobial testing. These strains were supplied by Pasteur Institute of Ivory Coast, Cocody (Abidjan).

1.2. Methods

1.2.1. Hydromethanolic extracts of germinated shea seeds

Extracts were prepared according to the method described by Guédé-Guina *et al.* (1997). For hydromethanolic extract 100 g of crushed shea seed cakes were homogenized in 1 L of 70 % methanol for 48 h under magnetic stirring, then filtered through absorbent cotton and Whatman paper. Filtrate obtained was evaporated at 40 °C in a VENTICELL oven. Concentrated powdered macerate was stored in dry, sterile bottles in the fridge at 4 °C for incorporation into creams.

1.2.2. Protein extracts from germinated shea seeds

Germinated shea seeds were first, crushed and delipidated with acetone solution. A fatless powder was obtained after evaporation using a rotary evaporator. Protein extraction from the previous powder consisted in a solubilization at pH 8 and isoelectric precipitation at pH 4.3, successively (Acosta *et al.*, 2016). Hence, 2.5 g of the delipidated shea seeds powder were suspended in distilled water at a ratio of 1 :10 (W/V).

The pH of the suspensions was adjusted to 8 with a 0.1 M NaOH solution. The resulting

This could suggest the exploitation of these germinated seeds in cosmetics and even pharmaceuticals. As body cream is one of the most common and practical forms of cosmetic preparation, it would be interesting to use it as an excipient to enhance the value of germinated shea seeds. This valorization will be pharmacological, as the emphasis will be on the antimicrobial properties of these creams. General aim of this study is therefore to enhance germinated shea seeds by highlighting their antimicrobial potential.

This was achieved by evaluating the antimicrobial activity of creams formulated with protein and hydromethanolic extracts of germinated shea seeds.

solution was centrifuged at 5000 rpm for 15 min at 4 °C. The supernatant was recovered and its pH was adjusted to 4.3 with a 2 M HCl solution. The final mixture was centrifuged at 10000 rpm for 20 min at 4 °C and the pellet was recovered and resuspended in distilled water (5%). Protein content was measured by spectrophotometry UV-visible at 214 nm. This method is based on the ability of proteins to absorb light in the ultraviolet range of light (Gavrillorie *et al.*, 1996). Bovine serum albumin (BSA) solution served for a standard line.

1.2.3. Formulation of creams from hydromethanolic and protein extracts of germinated shea seeds

Excipient of creams consisted in shea butter extracted from germinated nuts through Megnanou and Niamke (2015) process.

Cream formulation method described by Toé (2004) was used; it was modified by incorporating previous protein and hydroalcoholic extracts to aqueous phases. Hence two identical jar-glasses with, aqueous phase (water and extract) and oily phase (shea butter) respectively, were placed in a bain-marie at 82 °C. When the oily phase reached around 60 °C and the aqueous one 50 °C, both contents were mixed with a surfactant (tween 80) using an electric mixer: the oily phase was added dropwise under stirring (500 rpm), to the aqueous phase. The mixture, was kept in the bain-marie for 35 min and then removed and left to ambient air. Formulations ranged from 0; 0.5; 1; 2.5; 5; 10% of extracts and served to carry out the antimicrobial test.

1.2.4. Antimicrobial testing of creams from hydromethanolic and protein extracts of germinated shea seeds

Method used was that of Akakpo-Akue et al. (2009), which consisted in preparing stock suspensions (So) for each strain of fungus and bacterium by diluting a young colony aged 48 h in 10 mL of sterile distilled water. (So) carries a load of 10^6 cells / mL and is placed in direct contact with the cream formulated as follows:

In a test tube, 2 mL of formulated cream, 2 mL of sterile physiological water and 1 mL of microbial suspension (10^6 cells) were homogenized, giving a total volume of 5 mL. This suspension is sufficiently fluid to be sampled using a micropipette. A first control is prepared by homogenizing 1 mL of (So) in 4 mL of sterilized distilled water, to control germ growth.

A second control is prepared by homogenizing 1 mL of (So) in 2 mL of distilled water and 2 mL of cream formulated with 0% hydromethanolic

ous protein extracts, to control the antimicrobial activity of cream formulated without extracts. Test preparation followed the same procedure as previously described with the cream formulated with hydromethanolic and protein extracts at different concentrations (0.5% ;1% ;2.5 ;5% and 10%). Ten (10) microliters of each of the 6 preparations was withdrawn using a micropipette, then seeded by surface spreading of the cast agar on the petri dish. Cultures were incubated at different temperatures for different microorganisms, and readings were taken immediately after the incubation period. Inhibition percentages were calculated using the following formula :

$$\text{inhibition}(\%) = \frac{(\text{witness}) - (\text{essay})}{(\text{witness})} \times 100$$

2. RESULTS AND DISCUSSION

2.1. Results

2.1.1. Antimicrobial activity of creams formulated with protein and hydromethanolic extracts of germinated shea seeds on *Candida albicans*

Inhibition results for creams formulated with hydromethanolic and protein extracts of germinated shea seeds on *Candida albicans* showed a variation according to the concentration of the incorporated extract.

Creams containing protein and hydromethanolic extracts of germinated seeds generally inhibited the growth of *Candida albicans* to varying degrees (Table I).

Creams without hydromethanol and protein extracts had the lowest inhibition rate on *Candida albicans* (2.30 %), while those with extracts incorporated from 0.5 to 10 % had increasingly higher rates.

However, creams incorporating 10 % hydromethanolic and protein extracts of sprouted seeds show the best inhibition rates inhibition on *Candida albicans*, with respectively 56.05 and 50.19 % inhibition. However, creams incorporated with hydromethanol extracts showed a higher inhibition rate than those incorporated with protein extracts on *Candida albicans*.

Table I: inhibition rate of cream formulated with protein and hydromethanolic extracts from germinated shea seeds on *Candida albicans*

		Inhibition rate of cream on <i>Candida albicans</i> (%)					
Extract incorporation rate in cream (%)		0	0.5	1	2.5	5	10
Germinated seeds cream	Protein extracts	2.30 ± 0.02 ^f	4.23 ± 0.09 ^e	16.43 ± 0.10 ^d	31.37 ± 0.05 ^c	42.36 ± 1.01 ^b	50.19 ± 2.04 ^a
	Hydro-methanolic extracts	2.30 ± 0.02 ^f	10.39 ± 0.07 ^e	23.93 ± 0.15 ^d	33.12 ± 0.12 ^c	45.5 ± 0.92 ^b	56.05 ± 1.12 ^a

2.1.2. Antimicrobial activity of creams formulated with protein and hydromethanolic extracts of germinated shea seeds on *Staphylococcus aureus*

Creams formulated with hydromethanolic and protein extracts of germinated shea seeds also showed a variation in the rate of inhibition according to the concentration of the incorporated extract, and overall inhibited the growth of *Staphylococcus aureus* to varying

degrees (Table II). In fact, the results of the inhibition tests showed that creams without incorporation of the two types of sprout extracts induced the lowest inhibition rates on *Staphylococcus aureus* (6.37 %), while those with incorporated extracts ranging from 0.5 to 10%, showed higher rates depending on the concentration of the incorporated extract.

As a result, creams incorporating 10 % hydromethanolic and protein extracts of

sprouted seeds revealed the best inhibition rates on *Staphylococcus aureus*, with 83.33 and 80.88 % inhibition respectively. However, when comparing the two types of extracts, the inhibition rates induced by creams incorporated

with hydromethanolic extracts were higher than those obtained with creams incorporated with protein extracts on *Staphylococcus aureus* whatever the incorporated concentration.

Table II : inhibition rate of cream formulated with protein and hydromethanolic extracts from germinated shea seeds on *Staphylococcus aureus*

		Inhibition rate of cream on <i>Staphylococcus aureus</i> (%)					
Extract incorporation rate in cream (%)		0	0.5	1	2.5	5	10
Germinated seeds cream	Protein extracts	6.37 ± 0.14 ^f	14.7 ± 0.36 ^e	29.41 ± 1.71 ^d	35.78 ± 0.23 ^c	60.70 ± 1.78 ^b	80.88 ± 2.05 ^a
	Hydro-methanolic extracts	6.37 ± 0.14 ^f	22.54 ± 0.52 ^e	43.62 ± 1.40 ^d	58.82 ± 0.61 ^c	73 ± 0.46 ^b	83.33 ± 1.02 ^a

3. Discussion

Plant extracts have often been a source of bioactive molecules with therapeutic properties. Present study is part of a program to valorize germinated shea seeds, and aims to demonstrate their antimicrobial properties. More simply, it concerns butter based creams with protein and hydromethanolic extracts. Overall, these creams inhibited in vitro growth of *Candida albicans* and *Staphylococcus aureus* at dose-dependent rates depending on extract's concentration. This antimicrobial property could be due to the polyphenolic (flavonoids and tannins) and terpenic active ingredients in hydromethanolic extracts. These compounds have already been highlighted in shea nuts derivatives products (Megnanou et al., 2021) ; and the antioxidant ability demonstrated by the same authors. These results corroborate those reported by numerous authors who have demonstrated the effect of methanolic extracts of myrtle on numerous bacteria (Kashman et al., 1974 ; Appendino et al., 2002). These authors attributed the significant antibacterial effect of their methanolic extracts, particularly to phloroglucinols and polyphenols (Mansouri et al., 2001). Phenolic compounds are known to be toxic for many bacteria, and are thought to target microbial envelopes such as the cytoplasmic membrane or the cell wall. This effect is linked to their free hydroxyl group, which enables good solubilization in the medium (Oussou et al., 2004). What's more, these very high inhibition rates on *Candida albicans* and *Staphylococcus aureus* could be explained by the fact that the walls of these Gram-positive microorganisms are rich in proteins. Gram-positive microorganisms are less protected against antimicrobial agents, as peptidoglycan only hinders the diffusion of molecules above

50,000 D (Hogan et Kolter, 2002). Furthermore, it has been shown that the mechanism of flavonoid toxicity towards microorganisms is either through the deprivation of metal ions such as iron, or through non-specific interactions such as the establishment of hydrogen bridges with microorganism cell wall proteins (adhesins) or enzymes (Bruneton, 1999). Consequently, flavonoids, known for their powerful antioxidant properties, could potentially have an effect on iron chelation, preventing intracellular penetration of the Ca²⁺ cofactor to the microbial cell, thereby inhibiting their activity (Kokkini, 1996 ; Raj et al., 2001).

In addition to polyphenolic and terpene compounds with antimicrobial power, proteins/peptides play a major role in virtually all biological processes in the living world (Zoukimian, 2020). Protein extracts in the present study significantly inhibited the growth of microbial strains. This could be linked to the presence of active peptides with antimicrobial activity. Similarly, Beauclercq (2013) demonstrated an inhibitory effect of peptides derived from antimicrobial egg proteins on *Listeria monocytogenes* and *Salmonella enterica*. Related to the formulated creams, it should also be noted that creams without protein and hydromethanolic extracts also registered inhibition rate, how lower it. as compared to incorporated formulations. Such antimicrobial activity despite its slightness demonstrated the natural antimicrobial efficiency of germinated shea nuts butter, and would enhance germinated shea nuts pharmacological value. However extracts incorporation increased significantly that basal. Such results are conformed to those obtained by Akakpo-Akue et al. (2009) who

observed that plant extracts incorporation into creams at increasing rates significantly increased their potential antimicrobial activity. Furthermore, microbial strains were more sensitive to hydroalcoholic extracts than protein extracts. This could be explained by the fact that, in addition to phenolic compounds, hydromethanolic extracts also contain peptides/amino acids and many other active compounds (Kouakou, 2022). Indeed, these authors highlighted in addition to phenolic compounds, the presence of fatty acids, organic acids and many other active molecule able to induce biological activity to shea nuts sheels and

press cakes. The increasing antimicrobial efficacy of the formulated creams proved that shea germinated nuts extracts (protein and hydroalcoholic) would confer their pharmacological activity to any matrice their would be incorporated in. Such creams could valuably be proposed to people currently exposed to skin affections, if an in vivo essay is carry out in order to demonstrated their non-toxicity.

However, the big pharmacological potential of shea germinated nuts is once again highlight here, in addition to their antidiabetic and antioxidant efficacies.

Conclusion

The aim of this work was to enhance the value of germinated shea seeds by highlighting their antimicrobial potential. The study on antimicrobial activity of creams formulated with shea butter and extracts (proteins and hydroalcoholic) of these matrices showed that either formulation without incorporations or those with extracts incorporation have in vitro

antimicrobial activity. In other words, antimicrobial power of theses of germinated shea nuts on the in vitro growth of the pathogenic microbial strains (*Candida albicans* and *Staphylococcus aureus*), could makes them potential candidates for the development of drugs for the treatment of skin infections caused by these microbes.

Références

- Acosta C., Carpio C., Vilcacundo R., Carrillo W., 2016.** Identification of proteins isolate from amaranth (*Amaranthus caudatus*) by sodium dodecyl sulfate-polyacrylamide gel electrophoresis with water and NaCl 0.1 m solvents. *Asian Journal of Pharmaceutical and Clinical Research*, 9(3) :331-334.
- Akakpo-Akue J.M., Gbery I. P., Kra A. K. M., Zirihi N.G., Yapi F.H. & Djaman A.J., 2009.** Evaluation de l'activité antifongique et essai clinique d'une crème formulée à base de l'extrait X12 de *Terminalia catappa*, sur quelques mycoses superficielles. *Revue Ivoirienne Sciences. Technologie*, 13,175-190.
- Appendino G., Bianchi F. & Minassi A., 2002.** Oligomeric acylphloroglucinols from *Myrtus communis*. *Journal of Natural Products*, 65, 334-338.
- Baskin C.C., & Baskin J.M., 2001.** Seeds - Ecology, Biogeography, and Evolution of Dormancy and Germination. *Plant Ecology*, 152, 204-205.
- Beauclercq S., 2013.** Caractérisation de l'activité antimicrobienne de peptides dérivés de protéines antimicrobiennes de l'œuf. Mémoire de Master. Université François Rabelais -Tours (France), 24 p.
- Bonkougou E.G., 1987.** Monographie du karité, *Butyrospermum paradoxum* (Gaertn. F.) Hepper, espèce agroforestière à usages multiples. IRBET/CNRST, Ouagadougou. Burkina Faso. 67 p.
- Bruneton J., 1999.** Pharmacognosie, photochimie, plantes médicinales. 3ème édition Tec et Doc. Lavoisier, Paris, 1120 p.
- Djoman A.E.S., 2023.** Exploitation des potentialités des biomolécules actives issues des noix de karité germées et du beurre dérivé pour la formulation de produit diététique et pharmaceutique. Thèse de Doctorat. Université Félix HOUPOUET-BOIGNY. UFR Biosciences. Côte d'ivoire, 122 p.
- Gavrilorie M., Maginot M.J., Gavrilorie C.S., Wallach J., 1996.** Manipulation d'analyse biochimique. 3ème édition Doin Paris, 452 p.
- Guédé-Guina F., Kra A.M., Vangah-Manda M., Bonga G.M. & De Souza C., 1997.** Inhibition par MISCA-F2 de la croissance de *Aspergillus fumigatus* ; *Candida albicans* et *Cryptococcus neoformans*, 3 germes fongiques opportunistes au cours du SIDA. *African Journal of Biomedical Research*, 2, 11-16.
- Hall J.B., Aebischer D.P., Tomlinson D.F., Osei-Amaning E. & Dindle J.R., 1996.** *Vitellaria paradoxa*. A Monograph. School of Agricultural and Forest Sciences. University of Wales Bangor, 105 p.
- Hogan D. & Kolter R., 2002.** Why are bacteria referactory to antimicrobials. *Current opinion in Microbiology*, 5, 272-274.
- Kashman Y., Rotstein A., Lifshitz A., 1974.** The

structure determination of two new acylphloroglucinols from *Myrtus communis*. *Tetrahedron Letters*, **30**, 991-997.

Kokkini S., 1996. Taxonomy, diversity and distribution of *Oreganum* species. *Proceeding of the IPGRI International Workshop on Oregano*, **8**, 1-12.

Kouakou A.B., 2022. Efficacités antioxydante, antimicrobienne et cicatrisante de produits cosmétiques formulés à partir de coques et de tourteaux de noix de karité. Thèse de Doctorat Université Félix HOUPHOUET-BOIGNY, UFR Biosciences, Côte d'Ivoire, 132 p.

Kouamé I.A.D., 2019. Influence de la germination et de fermentation des grains de sésame (*Sesamum indicum* L.) sur la qualité nutritionnelle et fonctionnelle des farines et huiles dérivées. Thèse de Doctorat Université Nangui Abrogoua. UFR Sciences et Technologie des Aliments, Côte d'Ivoire, 185 p.

Kouyate A.M., Dembele U. & Lykke A.M., 2015. Les espèces ligneuses locales à huile : une ressource utile pour les communautés locales au Sud du Mali. *International Journal of Biological and Chemistry Science*, **9**(6), 2754-2763.

Mansouri S., Foroumadi A. & Ghanei T., 2001. Anti-bacterial activity of the crude extracts and fractionated constituents of *Myrtus communis*. *Pharmaceutical Biology*, **39**, 399-401.

Mégnanou R-M., Kouakou A.B. & Djoman A.E.S. 2021. Antioxidant efficacy of *Vitellaria paradoxa* nuts derivative products (butter, hulls and press cakes). *Universal Journal of Pharmaceutical Research*, **6**(4), 16-18.

Mégnanou R-M & Niamké A.S., 2015. Improving the optimized shea butter quality: a great potential of utilization for common consumers and industrials. *SpringerPlus*, **4**, 667-677.

Oussou K.R., Coffi K. & Nathalie G., 2004. Activité antibactérienne des huiles essentielles de trois plantes aromatiques de la cote d'ivoire. *Compte rendus de chimie*, **7**, 1081-1086.

Pesquet J.J., 1993. Le karité : perspectives commerciales pour un produit de cueillette. *Afrique Agriculture*, 39-40 p.

Raj N.K., Spiral R.M., Chaluvadi M.R. & Krishna D.R., 2001. Bioflavonoids classification, pharmacological, biochemical effects and therapeutic potential. *Indian Journal of Pharmacology*, **33**, 2-16.

Toé S.L.N.T.M., 2004. Essais de mises au point de formulation de crèmes et laits corporels à base du beurre de karité du Burkina Faso. Thèse de Doctorat. Université de Ouagadougou, Ufr Science de la Santé, Burkina Faso. 77 p.

Yé S., Lebeau F., Wathelet J.P., Leemans V. & Destain M.F., 2007. Étude des paramètres opératoires de pressage mécanique des amandes de *Vitellaria paradoxa* Gaertn C. F. (karité). *Biotechnology Agronomy Society and Environment*, **11**, 267-273.

Zoukimian C., 2020. Mise au point et industrialisation de la synthèse de peptides complexes. Mémoire de thèse. Université Grenoble Alpes, France, Ufr Chimie Moléculaire 216 p.