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Research Article

Preparation of Polyamide Nanocapsules of *Aloe vera* L. Delivery with *In Vivo* Studies

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Abstract. *Aloe vera* is the oldest medicinal plant ever known and the most applied medicinal plant worldwide. The purpose of this study was to prepare polyamide nanocapsules containing *A. vera* L. by an emulsion diffusion technique with *in vivo* studies. Diethyletriamine (DETA) was used as the encapsulating polymer with acetone ethyl acetate and dimethyl sulfoxide (DMSO) as the organic solvents and Tween and gelatin in water as the stabilizers. Sebacoyl chloride (SC) monomer, *A. vera* L. extract, and olive oil were mixed with the acetone and then water containing DETA monomer was added to the solution using a magnetic stirrer. Finally, the acetone was removed under vacuum, and nanocapsules were obtained using a freeze drier. This study showed that the size of the nanocapsule depends on a variety of factors such as the ratio of polymer to oil, the concentration of polymers, and the plant extract. The first sample is without surfactant and the size of nanocapsules in the sample is 115 nm. By adding surfactant, nanocapsules size was reduced to 96 nm. Nanocapsules containing *A. vera* were administered to rats and the effects were compared with a normal control group. The results showed that in the *A. vera* group, the effect is higher. The nanocapsules were identified by scanning electron microscopy (SEM), zeta potential sizer (ZPS), and Fourier-transform infrared spectroscopy (FT-IR).

KEY WORDS: *Aloe vera* L.; *in vivo*; medicinal plant; nanocapsule; polyamide nanocapsule.

INTRODUCTION

The medicinal uses of *Aloe vera* are amazing and the benefits of *A. vera* remedies are truly significant. *A. vera* is well-loved by many and a famed household plant. This plant is incredibly diverse in its uses. *A. vera* gel can be used as an aftershave, and its healing properties can treat small cuts caused by shaving. In recent years, an increased interest has developed in the nanoencapsulation of active ingredients (1,2).

Aloes have long been in use for several diseases, particularly connected with the digestive system; they have also been used for wounds, burns, and skin problems. The term aloes stands for the dried juice, which flows from transversely cut bases of its leaves. It is the best herbal answer to support the health and healing mechanisms of the body because it does not heal, rather it feeds the body's own systems in order for them to function optimally and be healthy (3). The leaf of *A. vera* is rubbery and smooth to touch from the outside, and inside the plant is the *A. vera* gel. It is available in a variety of products such as medicated cream, hand and body lotion, heat rub, pure *A. vera* juice, mini lift mask, medicated jelly, moisturizer, and etc. *A. vera* has a number of uses, and mainly it is used as a food preservative and medicine. Pure *A. vera* a is often used liberally on the skin. There are no reports that using aloe on the skin causes absorption of chemicals into the body that may cause significant side effects. Skin products that contain aloe alone or aloe combined with other active ingredients are available. When used externally, aloe is the best wound dressing ever discovered. It works by simultaneously sealing the wound while attracting an increased flow of blood to the wound, accelerating wound healing (4). Oil nanocapsules, whether in aqueous or solid form, are protected by a thin polymeric wall, which provides protection, permeability, and controlled release of the drug. Different methods and technologies can be applied to create polymeric nanocapsules such as a physicochemical process using a preformed polymer (5–8). Interfacial polycondensation is a chemical process based on a polymerization reaction often used for the preparation of microcapsules (9). Encapsulation of lipophilic material, which can be considered interfacial polycondensation, coupled to spontaneous emulsification of oil in water is a new patented process (10). In the present work, this technique has been used to produce nanocapsules based on polyamides. Different monomers were used to obtain these nanocapsules. Different polymers lead to different chemical structures which can lead to different polymeric walls. The size of the walls, which plays an important role in nanocapsules, depends on the physicochemical properties and in particular the crystallinity and the cross-linked structure of the material.

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A. vera has been used therapeutically, so in some countries, it is referred to with names like "plant of immortality," "herb," and "herbal queen" (11,12). *A. vera* has different properties ascribed to the inner, colorless, leaf gel and to the exudate from the outer layers. There is now less said about doubts as to the efficacy of the material, although there are some warnings of allergic side effects (13,14). However, many commentators clearly distinguish between the two parts and describe in some detail how the gel is prepared (15–17). The action of aloe gel as a moisturizing agent is still a popular concept and may account for much of its effect. Antifungal and even antiviral properties demonstrated by the gel are also often mentioned. Nevertheless, it should be noted that active glycoproteins have also been demonstrated in aloe gel and may well play some part in their therapeutic activity, either immunologically as lections or as proteasessuch as antibradykinins. There seems to be an ever-decreasing doubt that aloe gel has genuine therapeutic properties, certainly for the healing of skin lesions and perhaps many other conditions (16).

Therefore, nanocapsulation of *A. vera* and *in vivo* studies are considered a novel method for protecting them during drug delivery; hence, there is a need to study the conditions that influence the characteristics of the nanocapsules of *A. vera* in order to use them as functional ingredients in foods. In this study, the effect of nanocapsules containing *A. vera* was studied on rats and its positive results have been shown. The purpose of this research is the use of new technologies in the manufacture of *A. vera* nanocapsules, so the gel can be delivered to all tissues of the body.

MATERIAL AND METHODS

Chemicals

The monomers sebacoyl chloride (SC) and diethyletriamine (DETA) and acetone used as the solvent were supplied from Sigma-Aldrich, France. Surfactants (Tween 80 "Polysorbate 80" and Span 80 "Sorbitan monooleate") were supplied from SEPPIC, France. *A. vera* extract and pure water were also used.

Plant Material Extraction and Isolation

Dried, finely powdered aerial parts of *A. vera* (83.3 g) were dissolved in methanol in a Soxhlet extractor for 2 days. After the filtration and evaporation of the solvent, crude residue (28.3 g) remained.

Preparation Core–Shell Nanoparticles by Emulsion–Diffusion

Synthesis of Polyamide Nanocapsules Containing Extract in the Absence of Surfactant

First, SC monomer, *A. vera* extract, and olive oil were solved in 2 mL of acetone. After that, the organic solution was made, and this organic solution was drop-by-drop added to 10 mL of water containing the DETA monomer, at room temperature while the mixture was being stirred. After ultrasonic and dilute with water deionized removed solvent with rotary. Final sample filtered and it centrifuged. This helped in separating the stacked mass without contributing to the extraction of nanoparticles.

The nanocapsules were for left for about 8 h at 70°C and then transferred to a freeze drier system to release the water. The final products were brown powder nanocapsules containing *A. vera* extract.

Synthesis of Nanoparticles with Different Concentrations of Polymer

In order to study the effect of polymer concentration on nanocapsule behavior, four samples containing different concentrations of polymer with a weight ratio of polymer/oil 1:1 were prepared. The amounts of polymer in the samples were 5, 10, 20, and 40 mg, respectively. The amount of extract was fixed at 1.6 mg and the amount of oil was increased alongside the polymer to keep the ratio fixed. *A. vera* extract, SC monomer, and oil were solved in 2 mL of acetone and added drop-by-drop to 10 mL of water containing the DETA monomer while the mixture was being stirred.

Synthesis of Nanoparticles with Different Ratios of Polymer/Oil

In order to study the effect of polymer to oil ratio on nanocapsules, four samples containing different ratios of polymer/oil were prepared by keeping the polymer concentration (the sum of SC and DETA monomers) constant at 10 mg and varying the oil concentration to 20, 10, 5, and 2.5 mg, respectively. The amount of *A. vera* extract in food was 1.6 wt.%. The extract, SC monomer, and oil were solved in 2 mL of acetone and added drop-by-drop to 10 mL of the aqueous phase containing the DETA monomer.

Synthesis of Nanoparticles with Different Concentrations of A. vera Extract in Food

Four samples with different amounts of extract in food were prepared for studying the effect of extract on nanoparticle size. This time, the polymer/oil ratio was fixed and the concentration of extract varied. The amount of oil was 5 mg and the concentrations of the drug in the samples were 0.2, 0.3, 0.4, and 0.6 mg, respectively. The polymer/oil ratio was 1:0.5. Drug, polymer oil, and SC monomer were solved in 2 mL of acetone and added drop-by-drop to 10 mL of aqueous phase containing the DETA monomer.

Synthesis of Polyamide Nanocapsules Containing Extract in the Presence of Surfactant

First, SC monomer, *A. vera* extract, and olive oil were solved in 2 mL of acetone; after that, the organic solution was made and this organic solution was added drop-by-drop to 10 mL of water containing the DETA monomer, Tween 80 surfactant, and glycerin 50% at room temperature and stirred. A suspension solution was then prepared and exposed to ultra sonic, and after that, the acetone was released under vacuum, and the suspension solution containing nanocapsules was washed thrice with water without any ions and then centrifuged at 6,000 rpm. The prepared nanocapsules were left for

about 8 h at 70°C and then transferred to a freeze drier system to release the water; the final products were brown powder nanocapsules containing *A. vera* extract. The amount of oil was 5 mg; the amount of extract was 0.25 mg; and the amount of surfactant was 1, 3, 6, and 9 mg.

Synthesis of Nanoparticles with Different Types of Surfactant

Synthesis of Nanoparticles with Different Types of Hydrophobic Span Surfactant

To investigate the effect of different types of Span surfactants on the properties of nanocapsules, Span 20 and Span 60 surfactant samples containing a polymer/oil ratio of 1:1 were prepared with an extract feed rate of 1.6% by weight (0.25 mg), and Tween 80 surfactant was kept constant. SC monomer, *A. vera* extract, olive oil, and Span surfactant were solved in 2 mL of acetone. After that, the organic solution was prepared, and this organic solution was added drop-by-drop to 10 mL of water containing DETA monomer, Tween 80 surfactant, and glycerin 50% at room temperature while the mixture was being stirred.

Synthesis of Nanoparticles with Different Types of Hydrophilic Tween Surfactant

Table I shows the effect of different types of Tween surfactants on the properties of nanocapsules, and samples containing Tween 60 and Tween 80 surfactants in a polymer/oil ratio of 1:1 were prepared with the extract feed rate of 1.6% (0.25 mg) and the amount of surfactant was kept constant. SC monomer, *A. vera* extract, olive oil, and Span surfactant were solved in 2 mL of acetone; after that, the organic solution was made and this organic solution was added drop-by-drop to 10 mL of water containing the DETA monomer, Tween 80 surfactant, and glycerin 50% at room temperature while the mixture was being stirred.

Table II. Result of PSAR for different types of hydrophobic surfactant Tween

Sample	*A. vera* extract (mg)	Polymer/ oil ratio	Solvent type	Average size of particle (nm)
1	0.6	1.1	Acetone	96
2	0.6	1.1	Methanol	113
3	0.6	1.1	Ethyl acetate	319

Synthesis of Nanoparticles with Different Solvents

Table II shows the effect of solvent on the properties of nanocapsules, and samples containing equal amounts of three-phase organic with solvent weight ratio of polymer/oil 1:0.5 were prepared, with 1.6 wt.% of the feed extract (0.25 mg). SC monomer, *A. vera* extracts, olive oil, and Span surfactant were solved in 2 mL of acetone; after that, the organic solution was made and this organic solution was added drop-by-drop to 10 mL of water containing DETA monomer, Tween 80 surfactant, and glycerin 50% at room temperature while the mixture was being stirred.

Effect of A. vera Nanocapsule In Vivo

The ethical and practical problems of using human tissues have led to the development of a variety of model systems including *ex vivo* animal tissues. Among the larger experimental animals, rats have the advantage of being remarkably similar to humans in terms of anatomy, physiology,

Table I. Result of PSAR for different type factor's

Sample	*A. vera* extract (mg)	Polymer/oil ratio	Hydrophobic surfactant Span	Solvent type	Surfactant (mg) Tween	Polymer [polyamide (mg)]	Average size of particle (nm)
1	0.6	1.1	20		0.01		108
2	0.6	1.1	60		0.01		92
3	0.6	1.1	-	Acetone	-	-	96
4	0.6	1.1	-	Methanol	-	-	113
5	0.6	1.1	-	Ethyl acetate	-	-	319
6	1.6	1.1	-	-	5.0	-	73
7	1.6	1.1	-	-	10	-	81
8	1.6	1.1	-	-	20	-	96
9	1.6	1.1	-	-	40	-	108
10	1.6	1:2	-	-	-	10	207
11	1.6	1:1	-	-	-	10	137
12	1.6	1:0.5	-	-	-	10	115
13	1.6	1:0.25	-	-	-	10	92
14	0.2	1:0.5	-	-	-	10	108
15	0.3	1:0.5	-	-	-	10	126
16	0.4	1:0.5	-	-	-	10	132
17	0.6	1:0.5	-	-	-	10	167
18	0.6	1:0.5	-	-	0	10	115
19	0.6	1:0.5	-	-	1.0	10	96
20	0.6	1:0.5	-	-	3.0	10	84
21	0.6	1:0.5	-	-	6.0	10	67
22	0.6	1:1	20	-	0.01		99
23	0.6	1:1	60	-	0.01		73

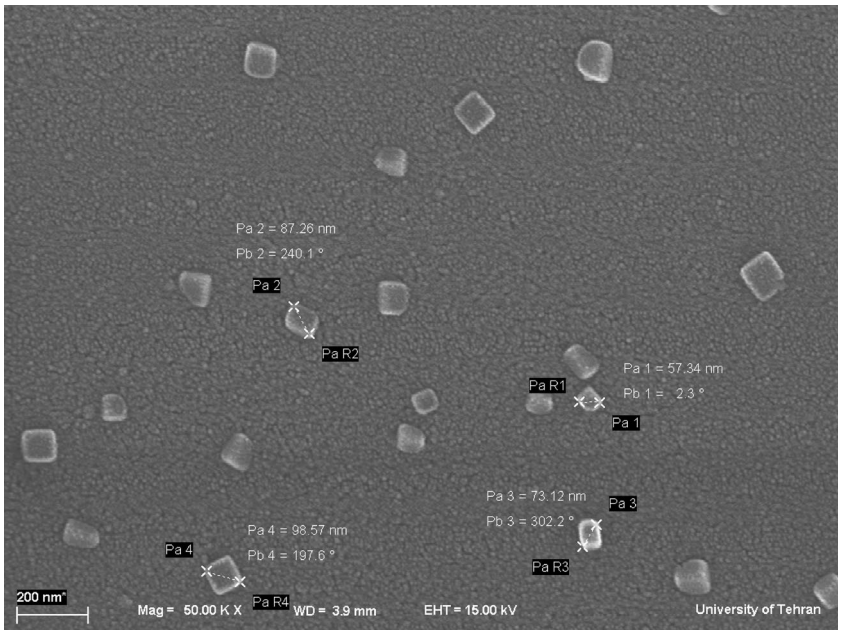

Fig. 1. Scanning electron microscopy of nanocapsules containing *A. vera* extract with surfactant (0.0015 g); oil (0.0013 g); and *A.vera* (0.0013 g)

metabolism, and histology. Furthermore, previous research works have reported the excellent correlation between human and porcine skin. Experiments were carried out on male rats weighing between 250 and 350 g on average.

In this method, normal control group (normal control) and treatment (treatment) were used. In each group, 20×30 mm of the skin of six male rats was shaved and sterilized by 70% ethanol, and then burns were created using caustic soda (NaOH). In the normal control group, immediately after the burn, antiburn ointment commonly available on the market (Sytvkalazyn) was applied. In the treatment group, nanocapsules of *A. vera* synthesized by polymer polyamide were applied. This was done once a day until recovery. As can be seen in the intestines of rats and necropsy, organ-specific toxicity was observed in these tissues.

RESULT AND DISCUSSION

Synthesis Core–Shell Nanoparticles by Emulsion–Diffusion Method

Since the core–shell structure prevents the direct contact of the drug, the polymeric core–shell structure is preferable compared to nanoemulsions. Degradation of the drug is minimized depending on the interactions between drug and physiological surrounding. With this property, the user of the drug will experience less irritation. The stability of nanocapsules depends on the polymer used for long-term storage (18).

The emulsion–diffusion technique is a two-step process comprising first of emulsion production and then of solvent diffusion. An emulsion is prepared from oil, a polymer, and a solvent and then diluted with water; the solvent diffuses and the polymers precipitate around the oil particles, forming nanocapsules. The process of emulsification consists of a solvent solved in water which diffuses immediately and pushes the process into the organic phase. Soon after this, the organic phase will enter the aqueous phase and consequently will lead to polymer precipitation around the oil particles. The aim of this process is to achieve consistent nanocapsules which have core–shell structure with solvent diffusion emulsion for leading the *A. vera* extract and olive oil in the acetone solvent.

Since the final size depends on the composition and emulsification process parameters of the primary emulsion, the influence of these parameters have been investigated in more details. The influences of the different parameters are discussed with reference to the simple breakup mechanism of the oil–liquid droplets caused by the shear stress, γ, under laminar flow (18).

Olive oil was selected for this study for several reasons. The viscosity of particular oil affects the droplet size; various vegetable oils have been compared by others, who have determined that olive oil possesses the highest viscosity and interfacial tension. With its ability to dissolve hydrophobic

Table III. Result of PSAR for different concentrations of polymer

Sample	*A. vera* extract (mg)	Polymer/ oil ratio	Polymer [polyamide (mg)]	Average size of particle (nm)
1	1.6	1.1	5.0	73
2	1.6	1.1	10	81
3	1.6	1.1	20	96
4	1.6	1.1	40	108

Table IV. Result of PSAR for different ratios of polymer/oil

Sample	*A. vera* extract (mg)	Polymer/ oil ratio	Polymer [polyamide (mg)]	Average size of particle (nm)
5	1.6	1:2	10	207
6	1.6	1:1	10	137
7	1.6	1:0.5	10	115
8	1.6	1:0.25	10	92

Table V. Result of PSAR for several amounts of extract in food

Sample	*A. vera* extract (mg)	Polymer/ oil ratio	Polymer [polyamide (mg)]	Average size of particle (nm)
9	0.2	1:0.5	10	108
10	0.3	1:0.5	10	126
11	0.4	1:0.5	10	132
12	0.6	1:0.5	10	167

compounds, olive oil can act as a bridge between hydrophobic and polymer compounds and help to dissolve hydrophobic and polymer compounds. Olive oil also possesses high biocompatibility and similarity to nutraceutical oils. The resulting solution is then put under ultrasound and then the acetone has been removed under vacuum (17–19).

Finally, for removing the water, the solution is transferred to a freeze drier system. The ultimate product is a nanocapsule powder containing the extract. Nanocapsules have core–shell structures in which the shell is polymeric and is surrounded by the hydrophilic part of PEG. The scanning electron microscopy (SEM) picture of nanocapsules is shown in Fig. 1.

Synthesis of Nanoparticles with Different Concentrations of Polymer

With increased SC monomer concentration in the organic phase, the viscosity of this phase will rise, and as a result, the solvent diffusion into the aqueous phase containing the DETA monomer will decrease. This causes the nanoemulsion drops to become larger. In other words, increased concentration of SC monomer in organic phase will diminish the contribution of the solvent in the emulsification and therefore the particle size will rise. With an increase in the polymer's concentration, the polymer–polymer interaction will decrease; this increases the difficulty in separating the polymer chains during the emulsification process and consequently the particle size increases (Table III).

Previous studies concerning synthesis of empty nanocapsules show that the concentration of polymer does not influence the overall size of nanocapsules. This size insensitivity towards the concentration of the polymer can be related to the emulsification conditions. Indeed, it is possible to increase the polymer content of the organic phase, while keeping the particle size constant, therefore increasing the polymer membrane thickness of the nanocapsules at a constant overall diameter (20,21). Comparison of the two methods showed that main problem was polymer concentration.

Synthesis of Nanocapsules with Different Polymer/Oil Ratios

Particle size increases with raised oil amount, because by increasing the oil amount in organic phase, the viscosity in organic phase increases, and as a result the size of nanocapsules will increase. The results indicate that, the efficiency of extract capturing will increase with increased amount of oil, but when the ratio is 2:1, this factor will decrease; in other words, an increase in the amount of oil will result in an increase in firstly, the amount of nanocapsules; secondly, the size of nanocapsules; and finally, the oil source of the nanocapsules core which is the site of integration for the loaded extract (Table IV).

In other investigations, researchers investigated the synthesis of nanocapsules of lipophilic drugs and found out that the size of nanocapsules increased with a decrease in the ratio of polymer to oil (21,22). In a relatively different approach, empty nanocapsules were investigated and it was observed that the nanocapsule diameter slightly increased with the oil concentration. This diameter change could be explained by the help of the Taylor curve, since an increase of the oil content of the nanocapsule in the organic phase makes it more viscous. Here again, the variation of diameter was very weak, showing that the experimental conditions were close to the minimum capillary number (22).

Synthesis of Nanoparticles with Extract in Food

There is often a need for nanosized carriers because the therapeutic requirements are not met by larger carriers. Especially for parenteral applications, nanoparticles are better compared to microparticles because they can be taken without any embolic risks. Furthermore, high food dependency or insufficient bioavailability after perioral processing can only be circumvented by carriers in the nanoscale (23). In particular, the nanocapsules containing *A. vera* extract can be used for medical and cosmetic products because they can solve issues like poor water solubility and active drug targeting. These applications make the study of nanocapsules vital. Nayak *et al.* evaluated the wound healing activity of *A. vera* extract in rats. They showed that the increased rate of wound contraction, together with the increased wound-breaking strength, hydroxyproline content, and histological observations, supports the use of *A. vera* in wound management (22).

The results show that with the increase in drug in course, the size of particle will decrease and this is due to the polymer structure. As it is well-known, polymers have semi-crystal structures that can be very irregular and can cause the formation of crystals in the nanocapsule structure. However, the interaction between extract and polymer will cause the aggregation of polymer in the nanocapsule structure and as a result will cause a decrease in the size of nanocapsules. By increasing the drug concentration from 0.3 to 0.6 mg in food, the size of particles will rise (Table V). This depends on the concentration of the extract; when the amount of extract in nanocapsules increases, the

Table VI. Result of PSAR for different surfactants of polymer

Sample	*A. vera* extract (mg)	Polymer/oil ratio	Polymer [polyamide (mg)]	Surfactant (mg)	Average size of particle (nm)
13	0.6	1.0.5	10	0	115
14	0.6	1.0.5	10	1.0	96
15	0.6	1.0.5	10	3.0	84
16	0.6	1.0.5	10	6.0	67

Table VII. Result of PSAR for different types of hydrophobic surfactant Span

Sample	*A. vera* extract (mg)	Polymer/oil ratio	Hydrophobic surfactant Span	Surfactant (mg) Tween	Average size of particle (nm)
1	0.6	1.1	20	0.01	99
2	0.6	1.1	60	0.01	73

extract acts as a clog factor and cases an increase in the particle size and decreases its stability. Previous studies of novel PEG-block-poly (aspartic acid-stat-phenylalanine) copolymer for a micellar drug carrier show that the presence of a significant amount of drug in the carrier is associated with an increase in the micellar size (23). A recent experimental work suggests that increasing the amounts of plant extract and drug will increase the size of particles accordingly. Therefore, polymer-coated particles are widely used for the preparation of paint, ink, pharmaceutical, and cosmetics. In this work, we coated *A. vera* by polyamide to make the absorption property on skin faster and increase the medicinal effectiveness of *A. vera*.

Synthesis of Nanoparticles with Surfactant

The nanocapsules are stable by spatial or electrostatic repulsion, depending on the surfactant type. The presence of surfactant is necessary to obtain a smaller and stable particle. The surfactant affects the physicochemical properties of nanoparticles, such as size, performance capture, and the amount of extract in nanoparticles. In this project, Tween 80 as a hydrophilic and nonionic surfactant has been used with different ratios in the aqueous phase. External aqueous phase surfactant concentration turned out to be a key factor affecting the particle size. Tween 80 concentration in the aqueous phase was changed to four samples

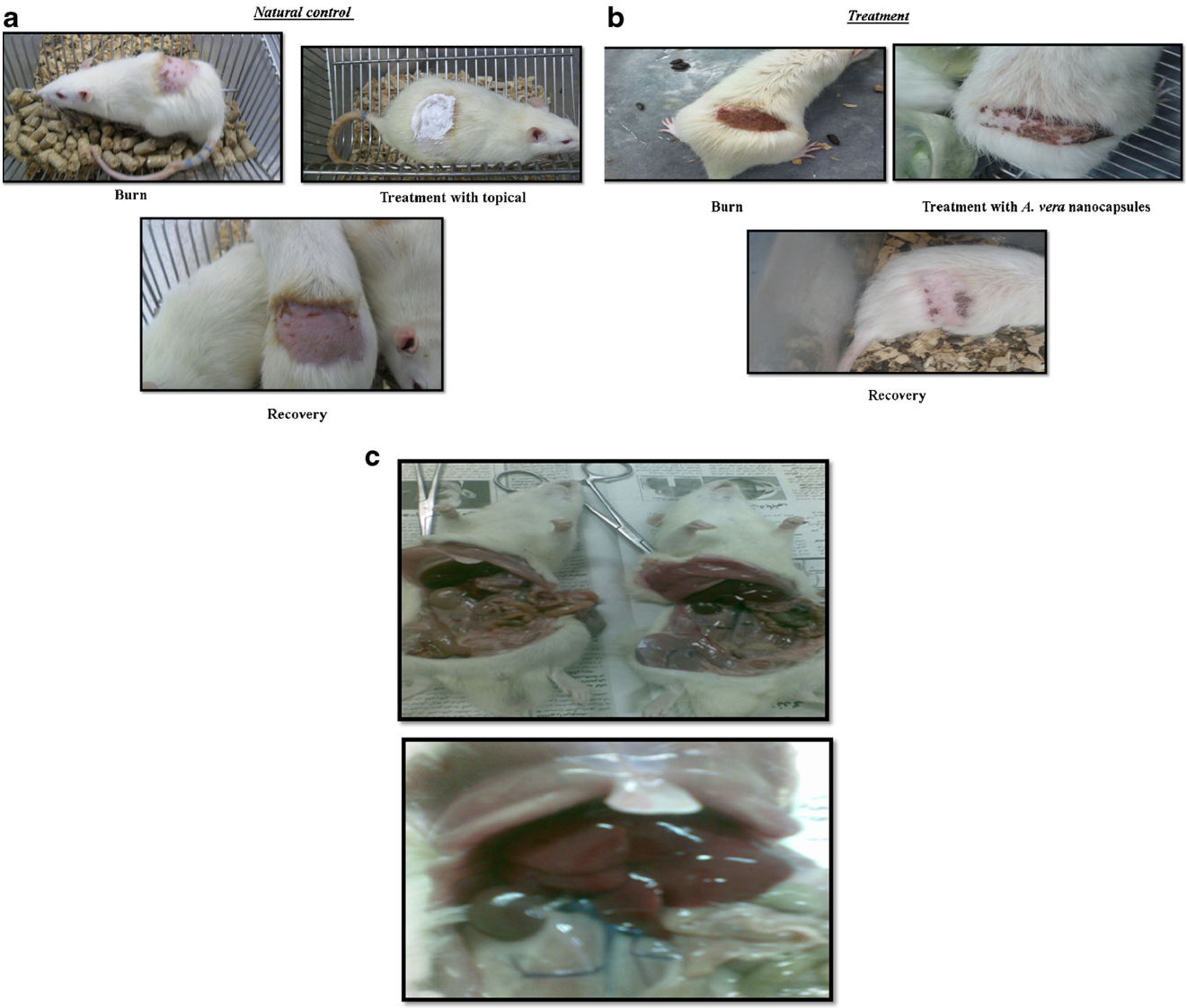

Fig. 2. **a** Comparison of *A. vera* extract of natural control; **b** comparison of *A. vera* extract in the treatment rats; and **c** comparison of *A. vera* extract in the rats and necropsy and organ-specific toxicity rats

and its effects on the properties of the nanocapsules were investigated. As can be seen, surfactant concentration has a significant effect on particle size. The first sample is without surfactant and the size of nanocapsules in the sample is 115 nm. By adding 1% surfactant, nanocapsule size was significantly reduced to 96 nm. Surfactant concentration increases the aqueous phase viscosity dramatically, which in turn increases the particle size (Table VI).

Synthesis of Different Types of Nanoparticles with Hydrophilic Tween and Span Surfactant

The surfactant type also has a significant effect on particle size. When Tween 60 and 80 and different Spans were added to the sample, the size of nanocapsules increased (Table VII).

Table VII compare the stabilizer Tween with other present stabilizers. The result shown with Span had the smallest mean particle size compared to those prepared. This might be due to the fact that gelatin has a variably large molecular weight depending on the source and method of extraction as it consists of a mixture of single or multi-stranded polypeptides. In addition, gelatin chains in general have the tendency to coalesce and permanently form large units, which may result in coalescence of the nanocapsules prepared with it. Also in the other methods, we only investigated with special solvent and surfactant to find larger nanosize in the extract of plant oil (24).

Synthesis of Nanoparticles with Different Solvents

Polymeric nanoparticles were produced with different solvents in order to investigate the effect of solvent on the properties of nanocapsules containing equal amounts of three-phase organic solvents. The boiling point of the solvent is responsible for solvent evaporation and the separation of the emulsion system. A higher boiling point means the nanocapsules will be formed later and therefore the nanosized capsules will be larger. The order of boiling point is as follows: ethyl acetate>methanol>acetone, and the trend for nano-sized capsules formation is the reverse of this order (23,24).

Effect of *A. vera* Nanocapsule *In Vivo*

Two groups, the normal control group (normal control) and the treatment group (treatment), were used. In each group, six male, Wistar rats had part of their skin shaved (20×30 mm). They were then sterilized by 70% ethanol and two burns were created on them using caustic soda (NaOH). Immediately after the burn, in the normal control group was applied, whereas in the treatment group, nanocapsules of *A. vera* synthesized polymer polyamide were applied. This was done once a day until recovery. In the normal control group, recovery took 1 week, while in the treatment group recovery was achieved after 10 days. Due to the low concentration, performance is acceptable for up to 21 days, so the result is accepted and approved. The intestines of the rats and necropsy showed that organ-specific toxicity was observed in these tissues (Fig. 2a–c).

In this study, the clinical effect of the methanol extract of the *A. vera* plant was examined on tissue from mice which had been damaged as a result of chemical burns, and the effect was compared with the effect of cytochalasin ointment. To achieve results, first, we obtained the extract of this plant and then applied this extract to the burned area twice a day until full recovery. The results obtained show that this extract in nanocapsule form was effective for the treatment of the wound after a period of 10 days. Based on the very low concentration of the extract, the treatment was acceptable when compared to the 7-day period required for the ointment, since healing times of up to 21 days have been reported. After this step, necropsy was performed on the mice and no signs of toxicity were found in their organs.

CONCLUSION

The purpose of this study was to prepare *A. vera* nanocapsule with *in vivo* studies. The effects of polymer and oil concentration, polymer/oil ratio, amount and type of surfactant, and solvent type were studied. *A. vera* extract nanocapsules on the process of healing of burn wounds in mice showed that *A. vera* increased the healing rate of burns in mice.

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