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# *ALOE VERA* AND METHYLSULFONYLMETHANE AS DIETARY SUPPLEMENTS: THEIR POTENTIAL BENEFITS FOR ARTHRITIC PATIENTS WITH DIABETIC COMPLICATIONS

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## ABSTRACT

High-molar-mass hyaluronan (HA) was used as a model biomacromolecule to study its *in vitro* oxidative damage. The main aim of the present study was to test Aloe Vera Freedom drinking gel and one of its components, methylsulfonylmethane, for their ability to protect HA from oxidative degradation.

The secondary objective was to monitor the blood glucose levels in a patient suffering from osteoarthritis and type II *diabetes mellitus* and taking Aloe Vera Freedom drinking gel. The oxidative degradation of high-molar-mass HA *in vitro* was initiated by the Weissberger system, comprising ascorbate and cupric ions, and monitored by rotational viscometry. The pro- and antioxidative activity of methylsulfonylmethane was determined by ABTS and DPPH decolorization assays. The patient's glycemia was monitored using a conventional glucometer for 41 days.

Dose-dependent protection of high-molar-mass HA from its oxidative degradation by Aloe Vera Freedom drinking gel was found. Methylsulfonylmethane, on the contrary, exerted a pro-degradative effect along with a poor reductive/antioxidative ability as revealed by the ABTS and DPPH tests.

Administration of Aloe Vera Freedom drinking gel had also a beneficial effect in reducing hyperglycemia. Concluding, a combination of standard treatment with supplementary dietary additive, such as Aloe Vera Freedom drinking gel, may improve hyperglycemia in some diabetic patients, while others may benefit from the possibility of lowering the dosage of the main drug.

**Keywords:** ABTS and DPPH assays, blood glucose levels, hyaluronan, oxygen free radicals, rotational viscometry

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## INTRODUCTION

On average, a healthy person reaches a lifespan of about 80–85 years in developed countries; women live usually longer than men. In fact, pre-menopausal women are considered to have a lower risk of common diseases than men. On the other hand, meno- and post-menopausal women often suffer from various articular degenerative disorders, with osteoarthritis to be mentioned first. Along with diabetic complications, which are classified in the present time as a "civilization disease", the last 2–3 decades of women's life may face several risks.

One of the possible solutions is the use of freely available drugs, painkillers – ibuprofen classifiable as first aid. Sufferers often extend these pain-inhibiting drugs with several dietary supplements, whose dazzling variety is advocated daily by sources of mass communication, including television, radio, billboards and printed sheets.

The main goal of the present paper is to provide particular knowledge of the authors obtained during their long-term research effort and based on their experience in the field of degenerative articular disorders and to report some findings on the effects of several commonly used pharmaceutical products.

## SYNOVIAL JOINTS, OSTEOARTHRITIS, AND PAIN

The adult human skeleton is unique regarding its 206 bones – their size, and mass. Bones, either individual or fused, are supported and supplemented by ligaments, tendons, and skeletal muscles. Articular ligaments and tendons are the main parts holding the joint(s) together. In respect to movement, joints may be classified as freely movable, partially moveable or immovable. Synovial joints, encompassing wrists, knees, ankles, shoulders, and hips, are freely moveable (cf. figure 1), enabling a large range of motion,

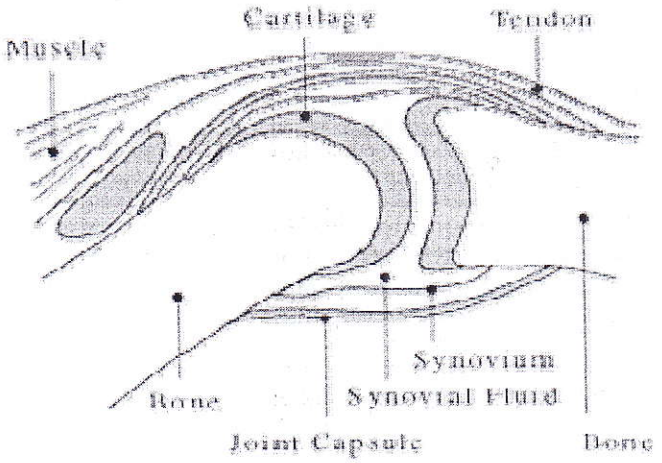



Figure 1. Normal, healthy synovial joint with its major parts [http://www.niams.nih.gov/Health_Info/Rheumatic_Dise\ase/graphics/joint_vert.gif (valid: August 14, 2012)].

A joint is formed by the ends of two or more bones connected by connective tissue. The function of the synovial joint in the human organism is to ensure motion of adjacent bones in the plane (bending $x \leftrightarrow y$) as well as in space (rotation $x \leftrightarrow y \leftrightarrow z$). Bone ends linked in the joint of healthy subjects are encased in a smooth hyaline layer – the cartilage. Figure 2 sketches a section of articular cartilage, where chondrocytes under normal physiological conditions permanently rebuild their extracellular matrix, i.e. the cartilage.

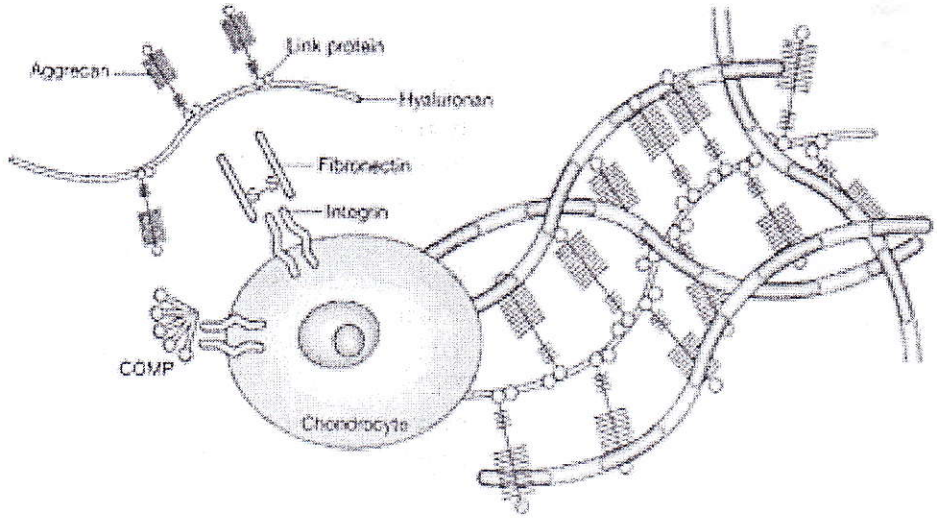



Figure 2. Articular cartilage – main components and structure [Chen *et al.*, 2006]. Three classes of proteins exist in articular cartilage: collagens (mostly type II), proteoglycans (primarily aggrecan), and other noncollagenous proteins (including link protein, fibronectin, COMP – cartilage oligomeric matrix protein) and small proteoglycans.

*Cartilage* belongs to mechanically highly stressed tissues in the human body. At walking, running or sprinting, the stroke frequency reaches approximately 0.5, 2.5 or up to 10 Hz, respectively. Cartilage functions as a shock absorber. This property is derived from its high water-entrapping capacity, as well as from the structure and intermolecular interactions among polymeric components that constitute the cartilage tissue [Servaty *et al.*, 2001]. The interaction between highly negatively charged cartilage proteoglycans and type II collagen fibrils is responsible for the compressive and tensile strength of the tissue, which has to withstand the overall load.

High age and weakened muscles may result in a destruction of most structures of the joint, which are then often subjected to surgery. Loose cartilage fragments along with bone spurs in the synovial fluids are not able to play their shock-absorbing role effectively. Mechanically irritated nerve endings in the bones of the joint are responsible for severe pain. If a non-physiological status persists, degenerative processes may prevail. Osteoarthritis (OA; cf. figure 3) represents a typical chronic degenerative disorder of the synovial joint.

One of the secondary markers of OA diseases is reduction of molar mass of synovial fluid (SF) hyaluronan (HA), which is free, i.e. non-protein bound. While the molar mass of HA in SF of healthy adult humans is up to 7 megaDaltons [Praest et al., 1997], the average molar mass of HA in OA is reduced to about 4 megaDaltons [Balazs, 1974].

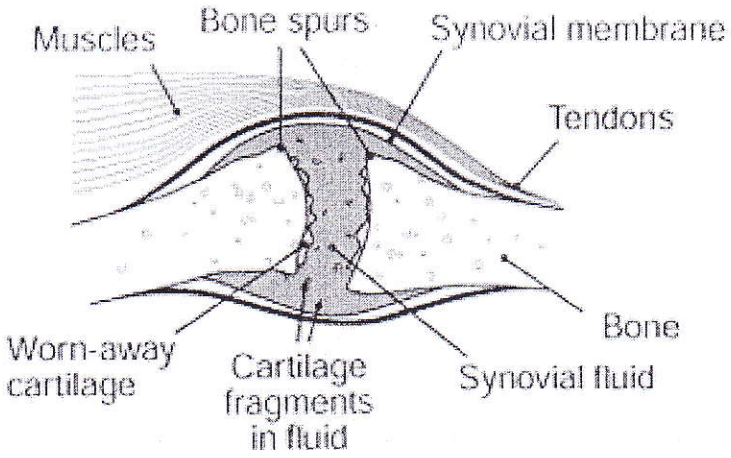



Figure 3. Osteoarthritic joint
[http://www.healthinplainenglish.com/health/musculoskeletal/osteoarthritis/joint-osteoarthritis.gif (valid: August 14, 2012)].

This may be the result of various causes. E.g. dysfunction of synovial membrane B-type synoviocytes may be involved resulting in a production of HAs with low molar size(s). Another possibility is that HA macromolecules of high-molar mass (7 megaDalton) extruded by normally functioning synoviocytes undergo free-radical-mediated oxidative degradation within SF.

*Hyaluronan:* Figure 4 represents the structural formula of HA (hyaluronic acid, hyaluronate) – regularly alternating disaccharide units composed from *N*-acetyl-D-glucosamine and D-glucuronic acid. The concentration of HA in the healthy human knee SF is 2.5 mg/ml on average [Kogan *et al.*, 2007]. While HA of the articular cartilage matrix is firmly associated via link proteins with proteoglycans (cf. figure 2), the HA macromolecules of SF are only loosely connected with proteins, if at all.

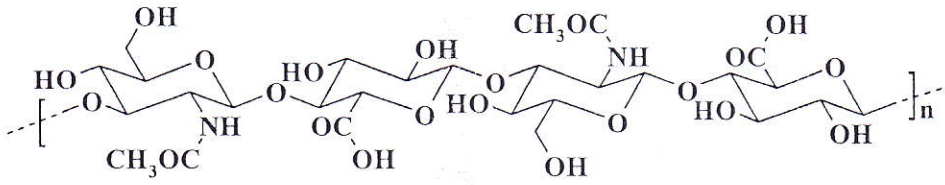


Figure 4. Hyaluronan – the acid form.

## Free-Radical-Mediated Oxidative Degradation of Hyaluronan

Many human diseases are associated with harmful action of reactive oxygen species (ROS) [Halliwell and Gutteridge, 1989]. These species are involved in oxidative modification and damage of essential biomacromolecules. Among them, synovial fluid (SF) high-molar-mass HA is of particular interest. The reported reduction of HA molar mass in the synovial

fluid of patients suffering from arthritic diseases led to *in vitro* studies on HA degradation by reactive oxygen species [Parsons *et al.*, 2002]. One of the earliest investigations was carried out by Pigman *et al.* [1961], and since then numerous studies have investigated the action of various ROS on HA(cf. Table 1).

**Table 1. Some *in vitro* studies on the degradation of high-molar-mass HA by chemically generated ROS**

| ROS | ROS generated chemically | References |
|---|---|---|
| $^{\bullet}OH$ | $H_2O_2$ + transitional metal cation | Li *et al.*, 1997; Orviský *et al.*, 1997; Praest *et al.*, 1997; Al-Assaf *et al.*, 1999; Jahn *et al.*, 1999; Šoltés *et al.*, 2001; Rees *et al.*, 2002; Šoltés *et al.*, 2005; 2006a; **2006b; 2007**; **Gao *et al.*, 2008**; Kennett and Davies, 2009; **Yang *et al.*, 2010**; Darzynkiewicz and Balazs, 2012 |
| $ONOO^-$ | $NaNO_2 + (H_2O_2 + HCl) + NaOH$ or $NaN_3 + O_3$ | Li *et al.*, 1997; Parsons *et al.*, 2002; Al-Assaf *et al.*, 2003; Corsaro *et al.*, 2004; Kennett and Davies, 2007 |
| OCl/HOCl | Hypochlorite | Baker *et al.*, 1989; Jahn *et al.*, 1999; Rees *et al.*, 2002; 2003; 2004 |

**Design of the study:** Practically any of the *in vitro* systems used for testing the antioxidative efficacy of a compound/drug commonly contains three components: i) an appropriate source generating reactive/oxidative species; ii) the antioxidant whose efficacy has to be tested; and iii) an appropriate marker indicating the course of the reaction [Barreto et al., 1995].

Of the studies listed in Table 1, the results of action of ibuprofen in its function as preventive antioxidant need to be specifically mentioned [Šoltés *et al.*, 2001]. Despite the well-established difference in the pain-blocking activity of the two enantiomers, ibuprofen has to date been marketed as the *RS-(±)-racemic* mixture in the majority of countries. Therefore, *antioxidative and/or free-radical-scavenging activities of both ibuprofen enantiomers and of the drug racemate were studied in vitro by measuring the kinetics of (uninhibited or drug-inhibited) degradation of high-molar-mass hyaluronan by hydroxyl radicals.*

*The continual flux of* $^{\bullet}OH$ *radicals at aerobic conditions was maintained by the* $H_2O_2$ + *Cu(II) system. The kinetics of hyaluronan degradation was monitored indirectly by capillary viscometry. When no drug added, the relative viscosity* $([\eta]_{rel})$ *decreased continuously, thus reflecting HA degradation, and reached ~13% of the initial* $[\eta]_{rel}$ *value in 4 h. Ibuprofen was found to exert a dose-dependent protection (cf. figure 5).*

As the synovial membrane is the proposed primary site of the inhibitory action of ibuprofen on prostaglandin synthesis, substantial ibuprofen concentrations should be attained within SF (the drug therapeutic window lies between 10 to 50 μg/mL). As evident (cf. figure 5) RS-(±)-ibuprofen showed that at the maximal drug concentration applied, *i.e.* at 43.6 mg/L, ibuprofen completely blocked the HA degradation in vitro. Hence, our findings may evidence that along with a known pharmacological action of ibuprofen, i.e. blockage of prostaglandin synthesis, the drug may prevent pathological free-radical-mediated HA degradation in SF.

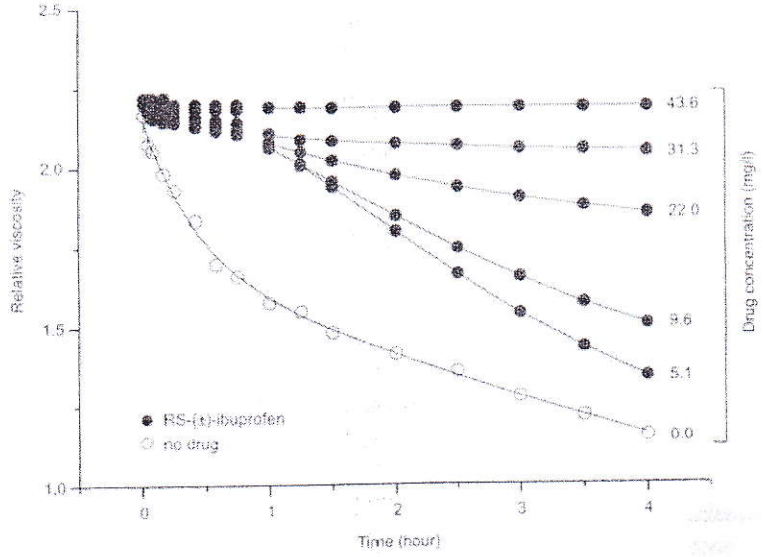



Figure 5. Inhibition by RS-(±)-ibuprofen of HA degradation induced by hydrogen peroxide + Cu(II).

The presence of $H_2O_2$ and Cu(II) was demonstrated in SF of the inflamed joint [Niedermeier, 1965]. Therefore, in one of our previous studies, we used a generator of free radicals of a composition qualitatively close to the given pathophysiological condition [Orviský et al., 1997]. In particular, hydrogen peroxide (c = 8.0 mmol/L) along with the transition metal ions of copper (c = 0.2 mmol/L) provided a constant flux of •OH radicals. However, to generate •OH, the reaction between Cu(II) and hydrogen peroxide requires an induction, whose mechanism has been proposed by Al-Assaf et al. [1995].

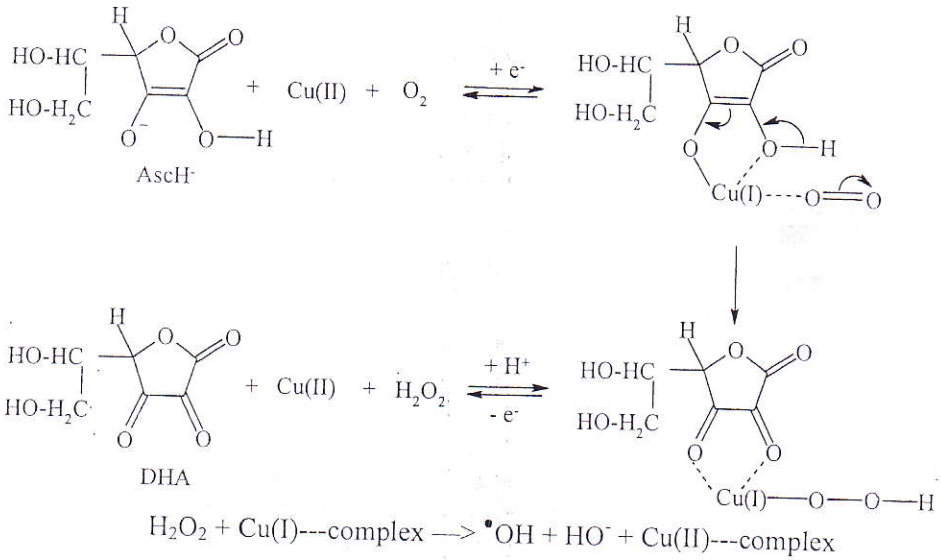
$$H_2O_2 + 2Cu(II) \longrightarrow 2Cu(I) + O_2 + 2H^+$$

The product of this reaction, Cu(I), is an actual reactant for the decomposition of $H_2O_2$ that in turn yields $^{\bullet}OH$ radicals. The $^{\bullet}OH$ radicals then abstract proton from the HA macromolecule.

The resulting HA (macro)radical ($A^{\bullet}$) reacts under aerobic conditions with molecular oxygen yielding a secondary peroxyl (macro)radical ($A\text{-}O\text{-}O^{\bullet}$). The latter participates in the phase of propagation of free-radical-mediated oxidative degradation of HA [Kvam et al., 1993; Orviský et al., 1997; Greenwald et al., 1980; Wong *et al.*, 1981; Saari *et al.*, 1993; Hawkins *et al.*, 1996].

To overcome some concerns about the Al-Assaf reaction (Al-Assaf *et al.* , 1995; $H_2O_2$ + $2Cu(II) \longrightarrow 2Cu(I) + O_2 + 2H^+$), particularly that of the presence of a proper reductant of Cu(II) under in vivo conditions, we considered the role of ascorbate present in SF. Therefore, in further experiments studying the high-molar-mass HA degradation in the presence of a trace amount of Cu(II), we applied ascorbic acid as a reducing agent.

All the mentioned components actually comprise a well-established Weissberger biogenic oxidative system (WBOS, Figure 6).




$H_2O_2$ + Cu(I)---complex —> $^{\bullet}OH$ + $HO^-$ + Cu(II)---complex

Figure 6. Chemistry of Weissberger's biogenic oxidative system: Hydrogen peroxide is generated by oxidation of ascorbate at catalytic action of Cu(II) ions [adapted from Hrabárová, PhD Thesis (in Slovak), Bratislava 2012c]. $AscH^-$ and DHA denote ascorbate anion and dehydroascorbate, respectively.

*WBOS*: Two different experimental arrangements were used when working with WBOS.

- First, by adding the substance tested for its protective effect against oxidative degradation of HA in time 0 min, i.e. the onset of free-radical generation, the substance capability to scavenge $^{\bullet}OH$ radicals and thus to act as a preventive antioxidant was addressed [Šoltés *et al.*, 2006b; Hrabárová *et al.*, 2011] (cf. table 2).
- Second, by adding the substance 1 h after the reaction onset, we investigated the ability of the substance to scavenge peroxy-type radicals, i.e. to act as a chain-breaking antioxidant [Valachová *et al.*, 2009a; 2010b; 2011a; Hrabárová *et al.*, 2011] (cf. table 2).

**Table 2. Some *in vitro* studies on the degradation of high-molar-mass HA by WOBS**

| ROS | ROS generated chemically | References |
|---|---|---|
| $^{\bullet}OH$ | Cu(II) + ascorbate | Šoltés and Kogan, 2008; Valachová *et al.*, 2008a,b; 2009a,b; 2010a,b,c,d; 2011a,b; 2012a,b; Hrabárová *et al.*, 2009; 2010 2012a,b; Dráfi *et al.*, 2010; Stankovská *et al.*, 2010; Baňasová *et al.*, 2012; Surovčíková-Machová *et al.*, 2012 |

*Aloe vera action:* Effects of Aloe vera preparation (Aloe Vera Freedom drinking gel, LR Health and Beauty Systems, Germany) on oxidative degradation of HA (2.5 mg/mL) initiated by 1 μM cupric chloride *plus* 100 μM ascorbate were investigated by adding 50 or 500 μL of the Aloe Vera preparation into the reaction system either before the onset or 1 h after the initiation of the reaction. Changes in dynamic viscosity of the HA due to its degradation were monitored via rotational viscometry (Figure 7).

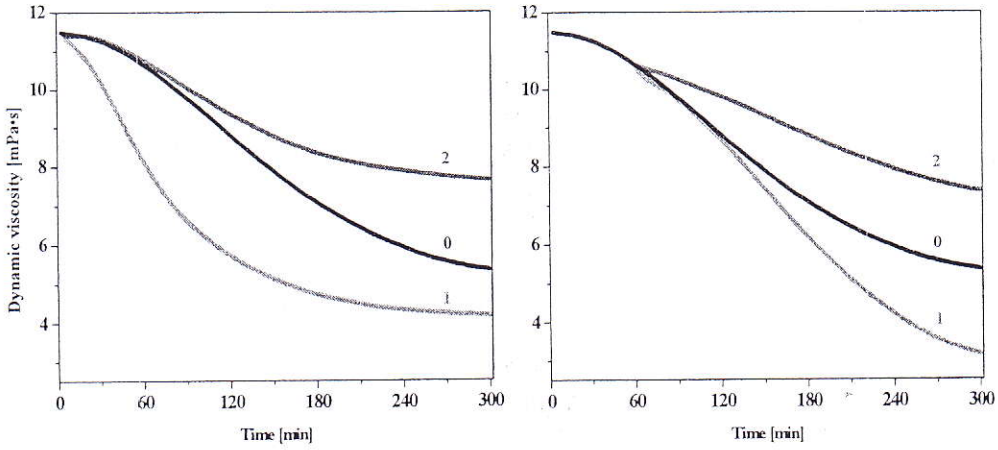



Figure 7. Effect of Aloe Vera Freedom drinking gel preparation on high-molar-mass hyaluronan degradation induced by 1 μM cupric chloride *plus* 100 μM ascorbate. Left panel – effect of the preparation added into the system before the onset of HA degradation, in μL: 1 – 50; 2 – 500. Right panel – effect of the preparation added into the system 1 h after the initiation of HA degradation, in μL: 1 – 50; 2 – 500. Reference: 0 – without the Aloe Vera preparation.

The results indicated that the Aloe Vera Freedom drinking gel tested added in a small volume of 50 μL into the system comprising hyaluronan, Cu(II) ions and ascorbate, acted pro-oxidatively (Figure 7, curve 1). The greater the volume of Aloe Vera preparation, the greater was the protective effect (Figure 7, curve 2). Aloe Vera preparation was interpreted to act as preventive antioxidant.

Since the Aloe Vera preparation contains a wide repertoire of trace elements and substances (cf. Table 3), the experiments performed may therefore be classified as a "black box" study. When the anti-oxidative effects of the Aloe Vera preparation prevailed over those of the pro-oxidative ones (on applying only 50 μL), a considerable retardation or even inhibition of HA degradation should be observed, as was the case on applying the volume of 500 μL.

Several studies have reported a beneficial effect of topically and orally administered *Aloe vera* preparations in patients suffering from various diseases, in particular angina pectoris, diabetes, psoriasis, wound healing, chronic venous leg ulcers, *etc.*

The above preparation, Aloe Vera Freedom drinking gel, contains among other supplements minimally three other components that are typically recommended for osteoarthritic complications, namely, chondroitin and glucosamine sulfates along with methylsulfonylmethane (MSM). Since the former two sulfates can be classified as chemically analogous to HA, we aimed our further investigation at the pro- or antioxidant action of MSM.

Figure 8 represents antioxidant action of MSM against $^{\bullet}OH$ radicals (left panel) and against peroxy-type radicals (right panel).

**Table 3. Aloe Vera Freedom drinking gel composition***

| Nutritional value | 100 mL** | The daily dose 90 mL |
|---|---|---|
| Energy value (kJ/kcal) | 131/31 | 118/28 |
| Carbohydrates | 6.9 g | 6.2 g |
| Proteins | 0.5 g | 0.4 g |
| Lipids | < 0.1 g | < 0.1 g |
| Vitamin E | 8 mg | 7 mg (58 % RDD) |
| Chondroitin sulfate | 500 mg | 450 mg |
| Glucosamine sulfate | 500 mg | 450 mg |
| Methylsulfonylmethane | 250 mg | 225 mg |

*Liquid nutritional supplement containing a concentrate of orange juice and vitamin E made for physically active humans and those suffering from locomotion apparatus disorders. Recommended dosage: 30 ml 3 times daily, optimally before food consumption (or to admix with water).

**Composition: Aloe Vera Barbadensis Miller Gel (USA/Mexico, 89 %), fructose, concentrate of orange juice, chondroitin sulfate, glucosamine sulfate, methylsulfonylmethane, citric acid, stabilizer: xanthan, preservation: potassium sorbate, sodium benzoate, natural orange aroma, antioxidative additives: ascorbic acid, vitamin E. RDD – recommended daily dose.

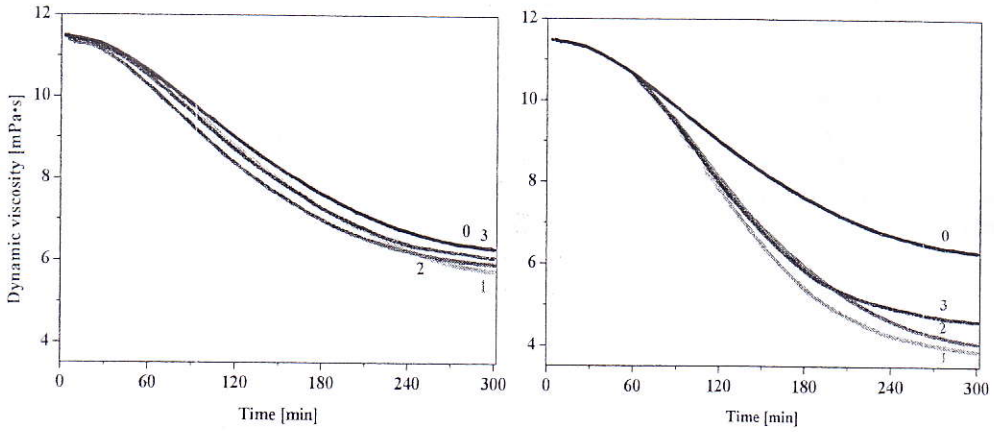



Figure 8. Effect of MSM on high-molar-mass HA degradation induced by 1 μM cupric chloride *plus* 100 μM ascorbate. MSM added into the system before the onset of HA degradation (left panel), in μM: 1 – 100; 2 – 400; 3 – 1000. Reference experiment: 0 – nil addition of MSM. MSM added into the system 1 h after initiation of HA degradation (right panel), in μM: 1 – 100; 2 – 400; 3 – 1000. Reference experiment: 0 – nil addition of MSM.

As evident from the results of Figure 8, left panel, no preventive antioxidative effect of MSM was detected even with the highest concentration used (1000 μM). The relationship of HA dynamic viscosity versus time demonstrated that MSM (100, 400, and 1000 μM) curves fell close to the reference curve. On the other hand, when applied 1 h after the reaction onset,

MSM (100, 400, and 1000 μM) exerted a clear pro-degradative effect. This should be taken into account when the preparations containing MSM are applied to arthritic patients. Their condition could be worsened by MSM, which may readily reach synovial joints and hence aggravate the pathology by promoting oxidative degradation of HA in SF.

Methylsulfonylmethane (MSM), preferred IUPAC name methanesulfonylmethane (Figure 9), occurs naturally in many plants and may thus be present in significant amounts in foods and beverages of natural origin.

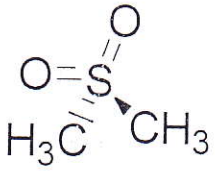


Figure 9. Chemical structure of methylsulfonylmethane (sulfur content: >34 mol. %)

MSM, a white crystalline, is often marketed as a dietary supplement. Its biochemical reactivity from the point of view of participation in redox reactions is rather limited since its S-atom is already in the highest oxidation state. Nonetheless, there are indications for MSM application as dietary supplement, specifically for *sulfur supplementation*, originating in 1985 when Herschler patented "Dietary and pharmaceutical uses of methylsulfonylmethane and compositions comprising it" [Herschler, 1985].

At present, MSM is sold and marketed as a dietary supplement, often in combination with glucosamine and/or chondroitin with indication to improve treatment and prevention of osteoarthritis [Kim *et al.*, 2006; Usha and Naidu, 2004; Brien *et al.*, 2008]. However, as claimed by Brien *et al.* [2008]: "No definitive conclusion can currently be drawn" and there is no "definitive evidence that MSM is superior to placebo in the treatment of mild to moderate osteoarthritis of the knee". Magnetic resonance studies revealed that orally applied MSM is well absorbed and readily crosses the blood-brain barrier [Rose *et al.*, 2000; Lin *et al.*, 2001, Engelke *et al.*, 2005].

According to our results, it is hard to build a strong case for its use other than for supplementation of sulfur, an element essential for building such structures of the joint as aggrecans.

Moreover, a high load of MSM into the inflamed joint may be harmful. Since the biochemical effects of supplemental MSM are poorly understood and some studies indicated that MSM has anti-inflammatory effects [Morton and Siegel, 1986], our further effort was to test this substance by standardized antioxidant tests, particularly by ABTS and DPPH assays. We tested MSM in a concentration range from 0.007 mM to 1 mM, but no antioxidative effect was found; on the contrary, MSM exerted a slight pro-oxidant effect.

## *Aloe Vera* and Type II Diabetes Mellitus

The primary tenet: "*Aloe Vera juice lowers blood glucose and triglyceride levels in diabetic patients*" [Yongchaiyudha *et al.*, 1996] stimulated us to carry out a pilot study applying Aloe Vera Freedom drinking gel (LR Health and Beauty Systems, Germany) to a

volunteer suffering from osteoarthritis and type II diabetes mellitus. Over the period of our study, the patient was treated for arthritis and taking the Aloe Vera preparation; she was inspected for mobility function as well as for glycemia routinely (Bayer glucometer – type Contour$^{TS}$). The glucose levels determined early morning are depicted in Figure 10. Throughout the follow-up study, the patient took her antidiabetics – Siofor, 1 gram, 2 times daily. Empty circles in Figure 10 show glucose levels when taking Siofor only, full circles show glucose levels when both Siofor and the Aloe Vera preparation were taken.

The first three measurements (Figure 10, empty circles) showed glucose levels in the patient treated with Siofor only. Her blood glucose levels were higher than in healthy humans, which usually fluctuate in the range of 4.4 and 6.7 mmol/L. Our data implicate that the patient is likely to have an impaired glucose tolerance (IGT). IGT and impaired fasting glucose tolerance (IFG) are considered prediabetic states. In IGT, the blood sugar level is chronically increased (7.8-11.0 mmol/L). In IFG, fasting glycemia is moderately increased (5.6-6.9 mmol/L). It is well known that diabetic patients with chronic hyperglycemia have a high risk of diabetic complications.

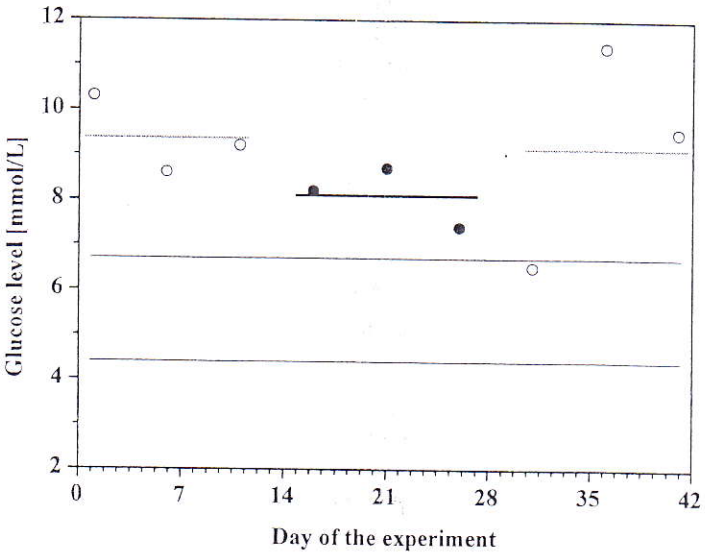



Figure 10. Blood glucose levels in the volunteer. Empty circles - volunteer is continually treated only with Siofor. Full circles - volunteer is continually treated with Siofor and with Aloe Vera Freedom drinking gel.

Over a period of taking Aloe Vera Freedom drinking gel along with the standard antidiabetic treatment (full circles, Figure 10), the patient's glycemia decreased on average to 8 mmol/L. This decrease may be attributed to a beneficial effect of the Aloe Vera preparation. After stopping the use of the preparation, the glucose level decrease deepened, reaching the value of 6.7 mmol/L on day 31, which falls within the desired range of 4.4-6.7 mmol/L. Subsequently however glycemia significantly increased (over 9-11 mmol/L). This observation remains unexplained, though it has to be noted that we cannot exclude an effect of stress reaction, as the patient was robbed at that time. It is known that old people when exposed to stress often get their blood glucose increased.

In summary, standard treatment along with the administration of a supplementary dietary additive, such as the Aloe Vera Freedom drinking gel, may help to reduce hyperglycemia. As a consequence, patients are likely to benefit also by the possibility of taking a lower drug dosage. Our findings are in good agreement with those of other authors [Yongchaiyudha *et al.*, 1996; Bunyapraphatsara *et al.*, 1996].

## CONCLUSION

In conclusion, we wish to summarize our experimental data in support for indication of taking the dietary supplements studied for specific pathologies.

1. Indications for taking the Aloe Vera Freedom drinking gel preparation in case of articular degenerative disorders:

- In the elderly, restoration of damaged cartilage is rather poor. WOBS has been used as a model of cartilage and HA damage.
- The Aloe Vera preparation dose-dependently prevented free-radical-mediated HA degradation; however, in small doses, a prooxidative effect was observed. As the preparation contains a variety of components, our effort was focused on disclosing the particular component that may be responsible for this prooxidative action.
- MSM, often used as a dietary supplement, demonstrated a clear prodegradative action in rotational viscometry experiments pointing to its possible prooxidative effect. Indeed, its reductive power was found poor by the ABTS and DPPH tests.

On balance, removing MSM from the Aloe Vera Freedom drinking gel preparation may be suggested.

2. Indications for diabetes mellitus type 2:

- Patients suffering from diabetes mellitus type 2 are frequently taking various drugs in relatively high doses. Aloe vera is often recommended to reduce the drug dosage usually taken.
- The Aloe Vera Freedom drinking gel preparation was effective in reducing hyperglycemia.
- The stress reaction, which affected the achieved euglycemia, is suggested to be readily reduced by a simple addition of tranquilizer-like acting dietary supplement.

MSM, detected as a risk component, could also be replaced by a tranquilizer of natural origin, which may to advantage contain a sulfur atom in its molecule to an advantage. We conclude that these dietary supplementation would provide a step forward for patients suffering from diabetes mellitus type 2 and degenerative joint disorders.

## ACKNOWLEDGMENTS

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