



Figure 2 : Morphological characteristics for lymphocytes (a) left untreated, and treated with (b) 1 % PHA, (c) 69 µg/ml ephedrine and (d) 69 µg/ml Ephedra extract (Scale 20 µm).

Ephedrine, like the catecholamines, has both direct and indirect adrenergic activity (27). However, catecholamines have a selected affinity towards one type of adrenergic receptor. For example, phenylephrine has a preferential α -adrenergic activity while norepinephrine and epinephrine possess higher β -adrenergic activity affinity. *In vitro*, β -adrenergic agonists tend to inhibit stimulated cells, including lymphocytes, while α -adrenergic agonists do not inhibit this activity (28). However, β -agonists have been shown to exhibit a stimulatory response on lymphocytes only in an *in vivo* system, involving a spleen-dependent process (29). Ephedrine differs from ephinephrine and phenylephrine as it lacks the two catechol hydroxyl groups which are responsible for α and β -adrenoceptor affinity. The N-substituted moiety and the β -hydroxyl moiety are particularly important for β -adrenergic activity (30). A distinguishing characteristic is that ephedrine has more activity at α -adrenoceptors rather than pseudoephedrine, and the opposite towards β -adrenoceptors. This suggests that the stereo-arrangement of the β -hydroxyl moiety is critical. As a matter of fact it can be concluded that owing to the fact that ephedrine is the most predominant alkaloid in the *Ephedra* branch extract and direct lymphocyte activation *in vitro* is mainly due to α -adrenoceptor activity, it leads to the conclusion that the *Ephedra* branch extract, more particularly ephedrine, exhibit a potent direct effect on

lymphocytes *in vitro*. In spite of this, the stimulation of a T-lymphocyte subset could be of importance in tumour immunology (31-33). This has been suggested for other plant metabolites, such as Amaryllidaceae alkaloids, extracted from *Crinum latifolium* L. (8, 9) and Cucurbitaceae terpenoids, extracted from *Ecballium elaterium* (L.) A.Rich (Cucurbitaceae) (34). Although *in vivo*, *Ephedra* (Ma Huang) has shown to cause mild myocyte hypertrophy and infiltration with lymphocytes, associated with ephedrine (35), its main constituent may be used as a lead compound for further immunomodulatory research.

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