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GALL formation occurs in many plants such as *Quercus*, *Acacia*, *Eugenia*, *Prosopis*, *Salvadora*, *Artemisia*, *Mangifera* etc. Gall represent a unique and complex interspecific interaction and mutual adaptation between the plant and the gall maker. The gall formation is due to an abnormal behaviour of cells of the affected plant organ to protect itself from the attack of cecidozoa or it is a case of extreme parasitism on the part of the insect to obtain free shelter and nourishment from the plant. The primary reaction of the plant is the neutralization of the toxin produced by the insect. Gall formation is caused by fluids injected into the plant tissues by the cecidozoa during feeding or egg laying. Investigations[1–3] have shown that the cecidogenesis is associated with the salivary secretions of cecidozoa. The development of a gall involves more or less pronounced localized enrichment of nutritive material and amino acids to an abnormal degree. Therefore, the present investigation is aimed at studying the free amino acid content in insect-induced plant galls.

Both healthy and gall formed plant portions of *Artemisia scoparia* L, *Prosopis spicigera* L and *Salvadora oleoides* Dine were collected as detailed in table 1.

Artemisia stem and leaf galls, *Prosopis* leaf and rachis galls, *Salvadora* stem and leaf galls, and curly leaf and corresponding healthy portions for comparison were collected separately. The galls thus collected were divided into two age groups, young and old, considering the size and colour of the gall. Both the healthy and galled parts were fixed in 70% ethyl alcohol to extract free amino acids. the insects were removed before fixing the material to avoid any possible extraction of amino acids from the insects. Later the fixed materials, both healthy and galled, were crushed and centrifuged to obtain clear extracts which were then transferred to 50 ml beakers and dried in an oven at 30–40°C. The residue thus obtained was weighed each time before dissolving in absolute alcohol to obtain equal concentrations. A known volume of normal and galled tissue extracts was used for spotting so that visual comparison for amino acids on the chromatogram was possible. Both paper and thin layer chromatography (TLC) were employed to separate free amino acids using butanol:acetic acid.water (4:1:5) and butanol:water (3:1) as solvent systems respectively. In both instances, plate or paper was air-dried, sprayed with 0.3% ninhydrin in 90% butanol and kept at 60°C. The chromatograms were obtained thrice for both control and gall tissue extracts using both paper and TLC. The intensity of colour developed was compared with the standard amino acid chromatograms.

Amino acids present in galls and normal plant parts were almost similar but the concentrations differed as noted by the colour intensities (table 2). The data showed 8 amino acids in *Artemisia* and 6 amino acids each in *Prosopis* and *Salvadora* galls. Proline which was found only in *Artemisia* decreased in quantity as the gall aged. Asparatic acid which was found only in *Prosopis*, increased in amount in galls. Valine and lysine were found only in *Salvadora* galls and their concentrations increased in leaf and stem galls whereas the amount decreased in curly leaf. However, the general observation was a gradual increase in the amount of amino acids in gall

Table 1 *Details of materials collected*

Name of the plant species	Time of collection	Parts affected	Causal organism
Artemisia scoparia	October to December	Shoot axis and leaf	*Rhopalomyia* sp
Prosopis spicigera	November	Leaf and	*Eriophyes prosopidis*
Salvadora oleoides	September to December	Stem and leaf	*Thomasiniana Salvadorae*

Table 2 *Distribution of free amino acids in insect-induced plant galls*

Plant species and component	*Amino acids*												
	Arginine	Aspartic acid	Gultamic acid	Glycine	Alanine	Tyrosine	Proline	Methionine	Leucine	Isoleucine	Valine	Amino butyric acid	Lysine
Artemisia Scoparia													
Healthy leaf and stem	+	–	–	++	+	++	++	+	++	++	–	–	
Immature gall (young)	++	–	–	++	+	++	++	++	++	+	–	–	
Mature gall (old)	+++	–	–	+++	+	+++	+	+++	++	++	–	–	
Prosopia spiciger													
Healthy leaf	++	+	–	–	++	–	–	–	++	+	–	++	
Leaf gall	++	++	–	–	+++	–	–	–	++	+	–	++	
Healthy rachis	++	++	–	–	+	–	–	–	++	+	–	++	
Rachis gall	++	+++	–	–	++	+	–	–	+++	++	–	++	
Salvadora oleoides													
Healthy leaves	–	–	–	++	+	–	–	–	+	–	++	++	++
Curly leaf	–	–	–	++	+	–	–	–	+	–	+	++	+
Leaf gall	–	–	–	+++	++	–	–	–	++	–	+++	++	+++
Healthy stem	–	–	–	++	++	–	–	–	+	–	+	++	++
Stem gall	–	–	–	+++	++	–	–	–	++	–	++	++	+++

+ : Colour indication very less (very small amount of the substance) ++ : Colour indication less (small amount of the substance) +++ : Colour indication more (more amount of the substance)

or malformed tissues as they grow older. It is likely that amino acids were injected into the tissues by the feeding insect as stated by Schaller[2] or that the proteins were broken down by proteolytic enzymes present in the insect larval saliva as earlier reported[1,4]. Anders[4] also reported that the concentration of amino acids such as lysine, histidine and tryptophan was high in gall tissues and that of glutamic acid and valine was low. But in the present study no such evidence was observed and glutamic acid was absent in all cases while valine showed an increase in *Salvadora* leaf and stem galls. The present study, though preliminary in nature, clearly suggests that amino acids like lysine, tryptophan, histidine, glutamic acid and valine were possibly not necessary to initiate gall formation as stated in earlier investigations. Instead, a mixture of amino acids in a particular proportion may be necessary to initiate cell proliferation leading to gall formation or an abnormal growth[3]. Therefore, as Anders[4] stated, the process of breaking down the proteins with the help of salival secretion not only serves as the aphid nutrient material but also as the cecodogenic material. In view of the preference of the gall-maker to a particular plant material it is suggested that the degree of abnormal tissue produced seem to be limited to the amount of or number of amino acids present.

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