

DISCOVERY OF EMMER WHEAT AND FENUGREEK FROM INDIA

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THE excavations of an ancient mound in the village Rohira (lat. 30° 35' N and 75° 50' E) in district Sangrur of Punjab, carried out by Punjab State Archaeology Department, Chandigarh, have revealed the evidence of rich and varied crop economy of the Harappans about C. 2000–1700 B. C. The carbonized grains have been recovered from trench C-8, stratum-4 at 1 meter depth (figures 1, 2).

The remains of emmer wheat (*Triticum dicoccum* Schubl.) (figure 1) and fenugreek seeds (*Trigonella foenumgraecum* L.) (figure 2) among the other crop remains already known from Harappan sites, have been discussed for the first time from India. It may be pointed out that the emmer, a wheat of West-Asia and Egypt, has been introduced into India very recently¹. Like the emmer, fenugreek also is indigenous to the countries bordering the eastern shores of the Mediterranean, extending to Central Asia². The finds of emmer and fenugreek both of Mediterranean region and Central Asia, in Harappan agricultural economy in India, seem to suggest an additional botanical evidence for the trade and cultural contacts of the Harappans with West-Asia.

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FATE OF ¹⁴C-CARBOFURAN IN A FLOODED ACID SULPHATE SALINE SOIL

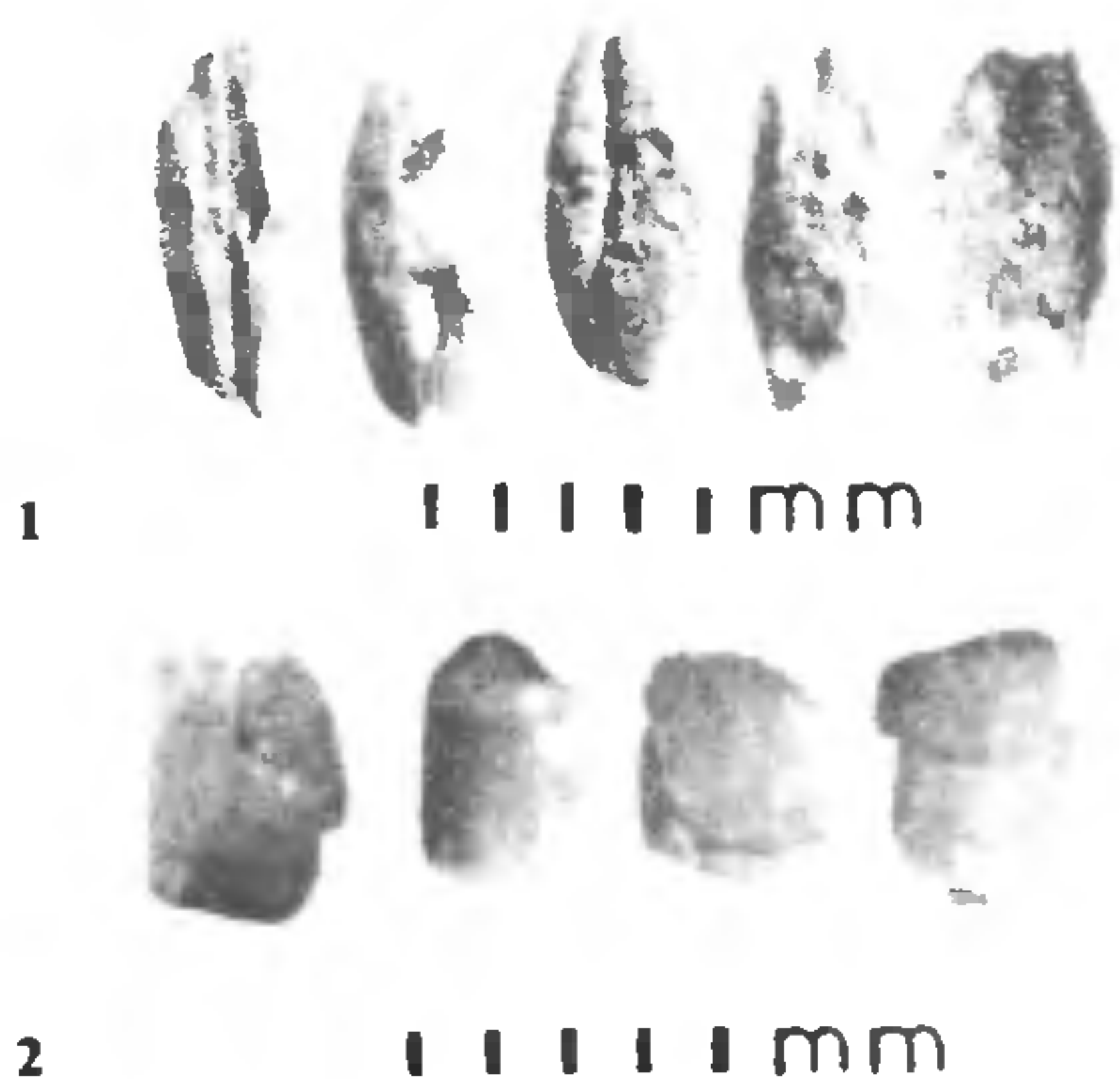
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RICE is extensively grown in unique acid sulphate saline soils locally known as 'kari'¹ in Kerala, South India, despite extreme conditions of low pH and high salt content. There are instances of intensive use of Furadan 3G (3% carbofuran, 2,3-dihydro-2,2-dimethyl-7-benzofuranyl N-methylcarbamate) in Kuttanad area, the rice bowl of Kerala, for effective control of rice brown planthoppers. Although carbofuran is relatively more water soluble with a lag of about 20 days in its degradation in most rice soils², detailed information on its fate in such problematic soils is rather limited. This paper provides an insight into the details of metabolic fate of ring- and carbonyl-labelled ¹⁴C-carbofuran under flooded conditions in kari soil, collected from Vechoor.

Twenty-gram portions of 'kari' soil (pH, 4.8; organic matter, 11.6%; total nitrogen, 0.12%) taken in test tubes (25 × 200-mm) were treated with aqueous solutions of ring-labelled or carbonyl-labelled ¹⁴C-carbofuran together with technical carbofuran to provide a final concentration of 50 ppm. The soil-water ratio was maintained at 1:1.25 (w/v) by flooding with distilled water and the tubes were incubated for 40 days. A separate set of tubes was kept for assaying ¹⁴CO₂ liberated during incubation as described earlier³. At 0, 20, 30 and 40 days, the carbofuran residues in two replicate soil samples were extracted thrice with



Figures 1, 2. Carbonised emmer wheat grains and fenugreek seeds from Rohira (Punjab) 1. Emmer wheat, 2. Fenugreek seeds.

chloroform-diethyl ether (1:1). The residues were then analysed by thin-layer chromatography and liquid scintillation besides determining the radioactivity that partitioned into the organic solvent and the water phase remaining after solvent extraction³. The extent of non-extractable soil-bound residues was also determined in Coleman carbon-hydrogen analyser as mentioned earlier³.

A balance sheet of the added radioactivity of ring- and carbonyl-¹⁴C-carbofuran in flooded kari soil is presented in table 1. No appreciable degradation of carbofuran occurred until 30 days after flooding. But at the end of 40 days, more than 81% of carbofuran degraded followed by a steady, but not proportional, increase in the recovery of non-extractable soil-bound residues. The fairly rapid degradation of carbofuran in this soil could be due to the striking rise in pH to near neutrality within 3 weeks after flooding, as in the case of most flooded soils⁴. The initial pH of 4.8 noticed at the time of flooding changed almost to neutrality after 20 days of flooding. On the other hand, according to an earlier report², 77% of carbofuran persisted in another acid sulphate saline soil, collected from Kerala, even after 40 days of flooding. That soil, however, was characterized by highly acidic conditions with a pH rise from 3.0 to 4.2 in the same period.

Autoradiographic analysis of ¹⁴C residues from ring-labelled ¹⁴C-carbofuran showed that the formation of carbofuran phenol was the major product of carbofuran metabolism, with 3-hydroxycarbofuran as a minor product. The extent of non-extractable soil-

bound residues differed with the position of ¹⁴C in carbofuran. Degradation of ¹⁴C-carbofuran led to more soil-bound residues from the carbonyl-portion than from the ring-portion. In view of the known resistance of ring-portion of organic molecules to degradation under anaerobic conditions, that exist in flooded soils⁵, the formation of low amounts of soil-bound residues from ring-¹⁴C in 'kari' soil as compared to that from carbonyl-¹⁴C is somewhat unique.

Getzin⁶ found that non-extractable ¹⁴C residues increased from 21–24% immediately after the application of ring-¹⁴C-carbofuran phenol to 70–80% at the end of 2 weeks in a nonflooded soil. However, it was not clear whether bound residues were carbofuran phenol or its degradation products. The formation of carbofuran phenol as the major breakdown product of carbofuran would probably explain the eventual formation of soil-bound residues in the present study in view of the reported strong binding of carbofuran phenol to the soils^{6,7}.

The radioactivity remaining in the water phase after organic solvent extraction of soil residues was also assayed. Water-soluble residues were substantial (13% of added ¹⁴C) from carbonyl-¹⁴C and negligible (1% of added ¹⁴C) from ring-¹⁴C-carbofuran. This is expected since the major reaction of hydrolysis at the carbamate linkage yields water-soluble products carrying ¹⁴C in the side chain such as methylcarbamic acid. As expected, the data on the evolution of ¹⁴CO₂ from ring- and carbonyl-¹⁴C-carbofuran applied to flooded kari soil are comparable to those obtained from flooded alluvial soil³. Thus, at the end of 40 days,

Table 1 Degradation of ring- and carbonyl-¹⁴C-carbofuran in 'kari' soil under flooded conditions.

| Type of ¹⁴ C label | Incubation, days | % Radioactivity recovered/20 g soil ^a | | | | | | |
|-------------------------------|------------------|--|-------------------------|-----------------------------------|--------------------------------|-------------------------|-----------------|----------------------------|
| | | Solvent phase ^b | Carbofuran ^c | 3-Hydroxy-carbofuran ^c | Carbofuran phenol ^c | Soil-bound ^d | CO ₂ | Water-soluble ^f |
| Ring | 0 | 78.39 | 71.66 | 0.44 | 1.72 | 1.40 | — | 1.01 |
| | 20 | 79.92 | 68.65 | 0.71 | 4.54 | 4.57 | 0.14 | 1.78 |
| | 30 | 54.91 | 43.45 | 0.68 | 7.28 | 5.91 | 0.66 | 1.34 |
| | 40 | 36.25 | 22.93 | 0.63 | 5.72 | 6.27 | 0.74 | 1.23 |
| Carbonyl | 0 | 84.10 | 75.18 | 0.30 | — | 13.08 | — | 2.11 |
| | 20 | 72.94 | 61.78 | 0.49 | — | 10.29 | 5.72 | 11.08 |
| | 30 | 51.08 | 44.76 | 0.27 | — | 7.63 | 14.31 | 13.49 |
| | 40 | 21.97 | 18.82 | 0.44 | — | 9.49 | 16.11 | 13.19 |

^a Per cent recovery of the initially added radioactivity, mean of two replicates.

^b Partitioned into chloroform-diethyl ether.

^c After tlc separation of the residues.

^d Non-extractable residues remaining after solvent extraction.

^e Cumulative estimate of ¹⁴CO₂ evolved.

^f Partitioned into the water phase after solvent extraction.

16% of the added radioactivity from the carbonyl-labelled carbofuran was recovered as $^{14}\text{CO}_2$ as against less than 1% from ring- ^{14}C -carbofuran. Our results clearly suggest that with a lag of 20 days, carbofuran degradation is fairly rapid even in problematic rice soils such as 'kari'.

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POST-INFECTION CHANGES IN ASCORBIC ACID CONTENTS OF MANGO AND AMLA CAUSED BY TWO FRUIT-ROT FUNGI

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ASCORBIC acid is believed to act as one of the biological oxidative-reductive substances. It is known to contribute resistance to host against pathogenic organisms, and is also decarboxylated with fungal enzyme system. Hence, in the present study changes in the ascorbic acid content of the two fruits (mango and amla) were studied during the pathogenesis of the two fruit-rot fungi.

Healthy and semi-ripe fruits of mango (*Mangifera indica* Linn.) and amla (*Phyllanthus emblica* Linn.) were inoculated with *Phomopsis mangiferae* Ahmad. and *Phoma exigua* Desm. respectively. Mango fruits were inoculated as described by Granger and Horne¹, while Amla fruits were infected with scalpel injury. They were wrapped with sterilized polythene bags and stored at $25 \pm 2^\circ\text{C}$. On every alternate day, fruit pulp weighing 5 g was ground in a mortar with glass fibre and 50 ml of 5% metaphosphoric acid was added slowly while grinding, and filtered through Whatman No. 42 filter paper. The filtrate was centrifuged at 2000 g. Ten ml of this was titrated against the 2-6-dichlorophenol-indophenol reagent as suggested by Bessey and King². The experiment was conducted in triplicate and repeated three times. The other details were similar to earlier methods³ and the results are given in table 1.

Table 1 shows a gradual decrease in the ascorbic acid content as the incubation progressed in both the fruits. The vitamin C content of mango fruits showed a gradual decrease with increase in storage period. In

Table 1 Post-infection changes in ascorbic acid (mg/100 g) of mango and amla fruits due to infection of two fruit rot fungi

| Fruit | Pathogen | | Days of incubation | | | | | Percentage* of loss |
|-------|-----------------------------|----------|--------------------|-------|-------|-------|-------|------------------------|
| | | | 0 (fresh) | 2 | 4 | 6 | 8 | |
| Mango | <i>Phomopsis mangiferae</i> | Healthy | 98.2 | 89.2 | 85.1 | 82.3 | 79.1 | 19.5 |
| | | Infected | 98.2 | 72.7 | 57.4 | 23.7 | 2.7 | 97.5 |
| Amla | <i>Phoma exigua</i> | Healthy | 402.7 | 401.3 | 396.2 | 390.4 | 386.4 | 6.6 |
| | | Infected | 402.7 | 210.0 | 163.2 | 121.5 | 52.3 | 87.0 |

* Total loss of ascorbic acid during the incubation of 8 days.