

Department of Agriculture, Bombay

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**MINERAL CONSTITUENTS OF FOOD
GRAINS, VEGETABLES AND CATTLE
FEEDS OF WESTERN INDIA**

BY

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MINERAL CONSTITUENTS OF FOOD GRAINS, VEGETABLES AND CATTLE FEEDS OF WESTERN INDIA.

I.—INTRODUCTION.

On account of a constant demand from the public for information about the composition of food grains, vegetables and fruits in Western India, a bulletin (Bulletin No. 124 of 1925) was published giving the general composition—such as fats, carbohydrates, albuminoids, etc., of these materials. A similar bulletin (Bulletin No. 161 of 1930) was published giving the composition of cattle feeds in Western India. In recent years there is a constantly increasing demand for information about the proportion of mineral constituents of the various materials dealt with in the two bulletins mentioned above.

It is now accepted on all hands that the mineral constituents of a food stuff are very important. Deficiency of any of the mineral constituents necessary for the body will be reflected in the health. The important mineral constituents are calcium, phosphorus, iron, sodium, chlorine, etc. Most of the food grains, vegetables and cattle feeds have been analysed for these constituents during the last two years or so. In the bulletins mentioned above it was possible to give variation in the composition of each type of material and also to give the composition of a normal sample as the analyses of a large number of samples of those materials were available. In the present case only one or two or at the most three samples were taken and analysed and hence the variation in the composition which is likely cannot be given. To obtain the variation it may be necessary to wait for years before a sufficiently large number of analytical figures can be had. In the meanwhile it is better to have the available information than have nothing. The material under vegetables analysed consisted of those parts which are actually cooked for consumption. It is with this object in view that the analytical figures for the mineral constituents of food grains, vegetables and cattle feeds are put together for the use of public.

The analytical tables include percentage of total ash, sand or acid insoluble matter, acid soluble, and from the acid soluble, iron (Fe_2O_3), lime (CaO), phosphoric acid (P_2O_5) and chlorides calculated as sodium chloride. The percentages are calculated on oven dry basis. The methods of analysis used were those usually used by Agricultural Chemists. (Official and tentative methods of analysis of the Association of Official Agricultural Chemists, U. S. A., 1932.)

The materials analysed fall into two main groups—(1) those that are ordinarily meant for human consumption and (2) those meant for cattle consumption.

The first group includes food grains and vegetables while the second group includes cultivated fodders, concentrates, husks, etc.

II.— HUMAN FOODS.

Human foods may be classified into (A) cereal grains, (B) pulse grains and pulses, (C) Oil seeds and (D) vegetables.

(A) *Cereal grains*.—Only those cereal grains which are in common use have been analysed for the mineral constituents. They are (1) rice (*Oryza sativa*), (2) wheat (*Triticum sativum*), (3) *jowar* (*Andropogon sorghum*), (4) maize (*Zea mays*), (5) *bajri* (*Pennisetum typhoideum*) called bulrush millet in English, (6) *vari* (*Panicum miliaceum*), (7) *nagali* or *ragi* (*Eleusine coracana*) and (8) *kodra* or *harik* (*Paspalum scrobiculatum*). The following are the ash analyses of these cereals.

TABLE I.

	Cleaned Rice (<i>Ambe-mohor</i>).	Wheat <i>Bazi</i> .	<i>Jowar</i> .	Maize.	<i>Bajri</i> .	<i>Vari</i> Cleaned Poona.	<i>Nagli</i> or <i>Ragi</i> Poona.	<i>Kodra</i> or <i>Harik</i> Poona.
				Per cent. on oven		dry matter.		
Total ash ...	0.62	1.91	2.03	1.26	1.96	1.54	2.52	4.18
Acid insoluble ...	0.17	0.62	0.27	0.04	0.44	0.22	1.88	2.56
Acid soluble ...	0.45	1.29	1.76	1.22	1.52	1.32	0.64	1.62
Containing:—								
Iron (Fe_2O_3) ...	0.06	0.07	0.13	0.04	0.13	0.07	0.12	0.41
Lime (CaO) ...	Traces	0.06	0.06	0.04	0.09	0.03	0.03	0.26
Phosphoric acid (P_2O_5).	0.35	0.97	0.63	0.57	0.95	0.67	0.34	0.61
Water soluble chlorides calcu- lated as sodium chloride.	0.04	0.07	0.04	0.05	0.05	0.02	0.03	0.03

The inferior millets *kodra* and *nagli* contain a high proportion of mineral matter especially iron. *Kodra* is rich in lime also. The rice grain is the poorest. It contains only traces of lime. Wheat, *jowar* and *bajri* grains compare well with each other but *bajri* seems to be better than *jowar* in all the mineral constituents.

(B) *Pulse grains*.—Pulse grains are seeds of leguminous plants. They contain more of mineral proportion than the cereal grains. They are also richer in lime and phosphoric acid than the cereal grains. In human food some of the pulses are used in the unsplit

condition as whole grains while others are used in the split condition. Two separate tables are given—one for the whole grains and the other for the split grains.

The table for the whole unsplit grains includes—(1) *tur* (*Cajanus indicus*) called Pigeon pea in English, (2) *gram* (*Cicer arietinum*), (3) *mug* (*Phaseolus mungo*), (4) *udid* (*Phaseolus radiatus*), (5) *masur*—lentil (*Ervum lens*), (6) *matki*—kidney bean (*Phaseolus aconitifolius*), (7) *chavli* (*Vigna catiang*), (8) *kulthi*—horse gram (*Dolichos biflorus*), (9) *val* (*Dolichos lablab*) and (10) *guvar*—cluster bean (*Cyamopsis psoralioides*).

TABLE II.

Unsplit or whole pulses.

	<i>Tur.</i>	<i>Gram.</i>	<i>Mug.</i>	<i>Udid.</i>	<i>Masur.</i>	<i>Matki.</i>	<i>Chawali.</i>	<i>Kulthi.</i>	<i>Val.</i>	<i>Guvar.</i>
	Per cent. on oven dry matter.									
Total ash	3.79	4.27	3.50	5.80	3.62	6.71	6.90	4.27	3.18	3.99
Acid insoluble	0.04	0.55	0.18	2.01	1.07	2.44	0.15	0.73	0.05	0.32
Acid soluble	3.75	3.72	3.32	3.79	2.45	4.27	5.75	3.54	3.13	3.67
Containing:—										
Iron (Fe_2O_3)	0.06	0.13	0.10	0.13	0.16	0.19	0.14	0.11	0.06	0.13
Lime (CaO)	0.06	0.16	0.50	0.02	0.06	0.06	0.04	0.16	0.07	0.04
Phosphoric acid (P_2O_5) ...	1.17	0.76	1.88	1.27	0.89	1.06	1.12	1.13	0.95	1.30
Water soluble chlorides calculated as sodium chloride.	0.05	0.02	0.13	0.05	0.06	0.30	0.08	0.03	0.08	0.02

All these grains are good in their ash contents containing generally more than three per cent. They are better in phosphoric acid than the cereal grains. *Kulthi*, *Val* and *Pawata* are specially rich in Phosphoric acid.

The table for split grains with husk removed includes:—

- (1) *Tur* (Eng. Pigeon pea) Bot. *Cajanus indicus*.
- (2) *Gram* (Poona) Bot. *Cicer arietinum*.
- (3) *Mug* Bot. *Phaseolus Mungo*.
- (4) *Udid* (Black gram) Bot. *Phaseolus radiatus*.
- (5) *Masur* (Lentil) Bot. *Ervum lens*.
- (6) *Matki* (Kidney bean) Bot. *Phaseolus aconitifolius*.
- (7) *Chawali* Bot. *Vigna catiang*.
- (8) *Kulthi* (Horse gram) Bot. *Dolichos biflorus*.
- (9) *White Val* Bot. *Dolichos lablab*.
- (10) *Pawata* pulse.

TABLE III.

Split pulse grains (with cover removed).

	Tur.	Gram.	Mug.	Udid.	Masur.	Matti.	Chawali.	Kulthi.	Val.	Pawata pulse.
	Per cent. on oven dry matter.									
Total ash	4.20	3.45	2.45	3.20	4.20	3.98	2.18	2.28	2.84	4.17
Acid insoluble	0.40	0.28	0.20	0.28	1.08	0.98	0.08	0.09	0.08	0.08
Acid soluble	3.80	3.17	2.25	2.92	3.12	3.00	2.10	2.19	2.76	4.09
Containing :—										
Iron (Fe_2O_3)	0.06	0.04	0.02	0.03	0.08	0.09	0.04	0.08	0.07	0.04
Lime (CaO)	0.56	0.45	0.56	0.34	0.56	0.18	0.09	0.08	0.07	0.06
Phosphoric acid (P_2O_5)	0.28	0.37	0.28	0.32	0.89	0.88	0.68	0.98	0.96	1.00
Water soluble chlorides calculated as sodium chloride.	0.04	0.10	0.04	0.02	0.03	0.02	0.05	0.02	0.03	0.05

A few samples of soya beans (Glucine soja) were analysed for the Live Stock Expert to Government, Bombay, Poona, and the figures obtained for the mineral constituents of these are given below :—

TABLE IV.

	Bankapur Farm		Poultry Farm, Kirkee.	
	Yellow mammoth.	Small soya bean.	Cooper's large mammoth.	Black soya bean.
	Per cent. on oven dry matter.			
Total ash	5.24	5.14	4.96	4.64
Acid insoluble	0.28	0.23	0.32	0.28
Acid soluble	4.96	4.91	4.64	4.36
Containing :—				
Iron (Fe_2O_3)	0.24	0.24	0.36	0.40
Lime (CaO)	0.11	0.11	0.22	0.17
Phosphoric acid (P_2O_5)	2.97	2.29	1.94	1.63
Potash (K_2O)	1.02	0.94	0.86	0.81

Soya beans have a high proportion of mineral matter which in its turn is rich in phosphoric acid. They are better than even *Kulthi*, *Val* and *Pawata* which pulses contain high proportions of phosphoric acid.

(C) *Oil seeds*.—Under this heading it is only those oil-seeds whose seeds are directly used in diets are included. They are (1) Groundnut (*Arachis hypogaea*), (2) *Til* or sesamum (*Sesamum indicum*), (3) Linseed (*Linum usitatissimum*), (4) Niger (*Guizotia abyssinica*), (5) *Kopra* or Coconut (*Cocos nucifera*) and (6) Rape seed (*Brassica campestris*).

TABLE V.

	Ground-nut.	<i>Til</i> or Sesamum.	Linseed.	Niger.	Kopra.	Rape seed.
			Per cent.			
Total ash ...	2.01	3.10	2.86	4.58	4.08	5.86
Acid insoluble ...	0.12	0.40	0.09	1.01	0.50	1.28
Acid soluble ...	1.89	2.70	2.77	3.57	3.58	4.58
Containing—						
Iron (Fe_2O_3) ...	0.04	0.02	0.08	0.04	0.02	0.06
Lime (CaO) ...	0.06	0.12	0.09	0.12	0.15	0.18
Phosphoric acid (P_2O_5) ...	0.88	1.20	0.96	1.34	0.98	0.86
Water soluble Chlorides calculated as sodium chloride.	0.04	0.02	0.03	0.02	...	0.04

Oil seeds are quite good in total mineral matter and also in phosphoric acid.

(D) *Vegetables*.—Vegetables contain a large percentage of water, sometimes upto 90 per cent. or more.

The dry matter contains 40 to 85 per cent. of soluble carbohydrates. Compared with the grains, a given weight of vegetables contains but a small quantity of material to supply energy for the body. But they are, especially the leafy vegetables, rich in mineral matter which is very essential to the body and the vegetables, therefore, form a very important part of the human diet. Fresh vegetables are now-a days considered as very valuable, apart from the actual weight of food material provided by them. They are so essential that, if possible, they should form a necessary part of human daily food. The importance of fresh vegetables seems to be due to the fact that they possess accessory food factors, better known as vitamins.

In this bulletin it is the mineral constituents that are dealt with.

The total ash or mineral matter as also such individual constituents as lime (CaO), phosphoric acid (P_2O_5), iron (Fe_2O_3), magnesia (MgO), Potash (K_2O), &c. were determined from important vegetables and they are given in the following tables.

The vegetables analysed have been grouped under three heads :—
 (1) Leafy vegetables that are eaten as whole plants, i.e., leaves together with tender portions of stems and shoots. (2) Vegetables, only the fruits (pods etc.) of which are utilised. (3) Vegetables which could not conveniently be grouped in either of the above classes.

(1) *Leafy vegetables where whole plants are used as vegetables.*

The list includes the following :—1 *Red math* (*Amaranthus clitum*), 2 *Rajgira* (*Amaranthus paniculatus*), 3 *Palak* (*Spinicea oleracea*), 4 *Chandanabatava* (*Chenopodium ambrosioides*), 5 *Karadi* or safflower (*carthamus tinctorius*), 6 *Methi* (*Trigonella Foenum graecum*), 7 *Chuka* (*Rumex vesicarius*), 8 *Kothimbir* (*Corriandrum sativum*), 9 *Pokla* (*Amarantus*), 10 *Ambadi* or Deccan hemp (*Hibiscus cannabinus*), 11 *Tandulja* (*Amarantus oleraceous*), 12 *Chakwat* (*Chenopodium album*), 13 *Mula leaves* (*Raphanus sativus*), 14 Lettuce (*Lactua sativa*), 15 Cabbage (*Brassica oleracea*).

TABLE VI.

Leafy vegetables the tender portions of which are eaten.

	Red Math.	Rajgira.	Palak.	Chan- dan- batwa.	Karadi.	Methi.	Chu- ka.	Kothim- ber.	Pokla.	Am- badi.	Tan- dulja.	Chak- wat.	Mula leaves.
	Per cent. on oven dry matter.												
Total moisture—													
Total ash	19.25	17.08	23.06	18.28	13.62	13.70	8.02	22.62	20.72	9.91	19.36	23.86	19.99
Acid insoluble (silicious matter).	2.20	2.15	2.80	3.06	0.22	2.60	1.45	4.17	2.65	0.95	2.21	1.83	0.92
Acid soluble	17.05	14.93	20.26	15.22	13.40	11.10	6.57	18.45	18.07	8.96	17.15	22.03	19.07
Containing—													
Iron (Fe_2O_3)	0.78	0.52	0.25	0.28	0.08	0.07	0.11	0.93	0.77	0.43	0.74	0.95	0.62
Alumina (Al_2O_3)	0.98	0.18	0.89	0.42	1.00	0.85	0.25	3.05	1.70	0.95	1.60	0.47	1.41
Lime (CaO)	1.12	0.88	0.49	0.56	0.09	1.04	0.04	1.03	0.47	0.66	1.62	0.60	2.34
Phosphoric Acid (P_2O_5)	1.27	1.86	3.41	2.55	1.05	1.06	0.06	2.88	3.38	1.36	1.93	4.81	0.99
Magnesia (MgO)	3.60	3.20	5.82	3.20	3.58	3.38	2.57	4.56	3.88	3.38	5.89	5.62	3.32
Potash (K_2O)	3.81	2.82	4.88	2.08	3.06	1.57	1.34	2.16	4.32	1.86	2.45	4.76	3.49
Water soluble chlorides as sodium chloride.	1.88	0.46	2.05	1.26	1.37	0.75	1.80	1.75	0.30	0.57	0.59	2.34	4.20

Vegetables are comparatively rich in mineral matter. Some of the leafy vegetables contain very high proportions. Ash contents of these were analysed as usual for the important constituents in acid soluble matter but the ash constituents of many leafy vegetables were determined from the water soluble portion also. There also they show a good amount of mineral material establishing the importance of leafy vegetables in diet. The water soluble ash constituents are given in table VII.

TABLE VII.

	<i>Alu</i> leaves.	<i>Palak.</i>	<i>Karadi.</i>	<i>Methi.</i>	<i>Chuka.</i>	<i>Kothim-</i> <i>bir.</i>	<i>Pokla.</i>	<i>Ambadi.</i>	<i>Tadulja.</i>	<i>Chak-</i> <i>wal.</i>	<i>Mula</i> leaves.	Lettuce.
						Per	cent. on	oven dry	matter.			
Total ash ...	14.86	20.82	12.28	13.80	8.02	20.82	18.27	9.08	19.18	20.11	19.10	18.90
Containing												
Total water soluble salts ...	5.11	7.08	4.28	7.20	6.28	7.96	9.82	3.25	5.28	11.01	8.15	6.12
Containing												
Calcium carbonate ...	0.20	0.20	0.62	...	0.58	0.72	...	0.48	...	...	1.08	0.28
Magnesium carbonate ...	0.73	0.98	0.57	1.47	0.61	0.73	0.98	0.32	1.08	1.44	0.73	0.62
Magnesium sulphate ...	1.50	0.22	0.41	1.19	...	1.48	...	...	0.15	...	1.82	...
Sodium carbonate ...	0.48	1.24	0.88	1.84	0.72	1.24	2.50	0.42	1.46	3.99	0.42	1.25
Sodium bicarbonate ...	0.05	0.99	...	...	1.54	...	3.59	0.57	...	2.50	...	1.08
Sodium sulphate ...	0.82	0.97	0.12	1.26	0.48	1.20	0.96	0.24	0.08	0.48	1.20	0.48
Chlorides as Sodium chloride ...	0.60	2.05	1.32	0.98	1.80	0.62	0.30	0.57	0.59	2.51	3.42	2.11

Vegetables where the fruits are used include the following important ones:—

1 Red *Bhopala* or red pumpkin (*Cucurbita maxima*), 2 *Dudhya Bhopala* or long white gourd (*Lagenaria vulgaris*), 3 *Padwal* or snake gourd (*Trichosanthes anguina*), 4 *Ghevda* or French beans (*Phaseolus vulgaris*), 5 *Karale* or bitter gourd (*Momordica charantia*), 6 *Dodka* (*Luffa acutangula*), 7 *Vange* or Brinjal (*Solanum melongena*), 8 *Guar* (*Cyamopsis psoraloides*), and 9 *Bhendi* or lady's finger (*Hibiscus esculentus*).

TABLE VIII.

	Red <i>Bhopala</i> .	<i>Dudhya Bhopala</i> .	<i>Padwal</i> .	<i>Ghevda</i> .	<i>Karale</i> .	<i>Dodka</i> .	<i>Vange</i>	<i>Guar</i> .	<i>Bhendi</i> .
Total moisture—			Per	cent.	on oven	dry	matter.		
Total ash ...	8.00	6.21	5.80	6.20	8.22	6.12	6.88	7.10	7.20
Containing—									
Acid insoluble (silicious matter).	0.15	0.12	0.12	0.24	0.18	0.18	0.68	0.04	0.28
Acid soluble ...	7.85	6.09	5.68	5.96	8.04	5.94	6.20	7.06	6.92
Containing—									
Iron (Fe_2O_3) ...	0.20	0.12	0.08	0.03	0.90	0.08	0.08	1.00	0.86
Alumina (Al_2O_3)...	0.30	0.14	0.06	0.02	1.20	0.07	0.04	0.88	0.58
Lime (CaO) ...	0.45	0.32	0.28	0.14	0.34	0.45	0.20	0.43	1.12
Phosphoric Acid (P_2O_5).	0.81	0.61	0.31	0.68	0.53	1.38	1.70	1.05	0.61
Magnesia (MgO)...	1.80	1.88	0.58	0.34	1.00	1.20	1.00	1.32	1.60
Potash (K_2O) ...	1.78	1.32	0.68	0.78	1.78	0.98	1.86	1.48	1.23
Water soluble Chlorides as Sodium chloride.	0.58	0.38	0.62	0.48	0.58	0.48	0.62	0.50	0.28

There are several other vegetables which cannot be included in the above two groups. They are mostly roots and tubers :—

1. Cauliflower (*Brassica leracea*) Var—*Botrytis*.
2. Knol-khol (*Brassica oleracea*) Var—*Caulocarpa*.
3. *Mula* or raddish (*Raphanus sativus*).
4. Carrots (*Daucus carota*).
5. Yams. (*Dioscorea alata*).
6. *Suran* (*Amorphophallus campanulatus*).
7. *Ratala* or Sweet-potatoes (*Ipomoea batatas*).
8. Potatoes (*Solanum tuberosum*).
9. Onions (Red *Allium cepa*).
10. Garlic (*Allium sativum*) and
11. Chillies (*Capsicum frutescens*).

All these are rich in mineral matter though not quite so rich as the leafy vegetables.

TABLE IX.
Other vegetables.

	Cabbage.	Cauliflower.	Knolkhol.	Mula or Radish	Carrot red.	Yams.	Suran.	Sweet potatoes.	Potatoes.	Onions.	Garlic.	Chillies.	Lettuce.	
	Per cent. on oven dry matter.													
Total moisture ... ..	...	...	...	...	...	...	...	...	...	...	...	...	...
Total ash	6.28	7.88	10.89	13.81	5.87	4.04	7.13	4.12	5.66	4.10	3.81	6.82	19.87	
Acid insoluble (Silicious matter.)	0.10	0.18	0.14	1.96	0.27	0.48	0.20	0.18	0.16	0.58	0.42	0.38	3.65	
Acid soluble matter	6.18	7.70	10.75	10.85	5.60	3.56	7.93	3.94	5.50	3.52	2.39	4.44	16.22	
Containing—														
Iron (Fe_2O_3)... ..	0.28	0.34	0.58	0.41	0.66	0.22	0.27	0.12	0.10	0.05	0.02	0.08	0.69	
Alumina (Al_2O_3)	0.32	0.52	0.88	0.86	0.48	0.26	0.14	0.10	0.16	0.08	0.05	0.04	1.32	
Lime (CaO)	1.88	0.04	0.68	0.11	0.09	0.06	0.18	0.33	0.26	0.09	0.40	0.53	0.97	
Phosphoric Acid (P_2O_5)	0.74	1.14	1.07	0.65	0.60	0.48	0.72	0.66	0.77	0.25	0.31	1.06	1.18	
Magnesia (MgO)	0.58	0.40	1.60	1.88	0.48	0.32	0.28	0.28	0.34	0.26	0.12	0.28	4.45	
Potash (K_2O)	3.34	3.13	4.47	0.58	1.08	0.98	2.04	2.10	2.61	0.28	0.80	2.81	4.40	
Water soluble Chlorides as Sodium chloride.	0.30	0.42	0.68	2.28	0.28	0.18	0.16	0.18	0.14	0.08	0.10	0.38	1.95	

III.—CATTLE FEEDS

Cattle feeds include (A) seeds and oil-cakes, (B) Bhusa and husks, (C) fodders from cultivated crops and (D) green leaves, etc., from various plants.

Besides these, there are many grasses. In this bulletin only the important feeds from the first three classes have been given. The composition of seed grains is given under human foods in Part II and therefore the table below do not include those.

(A) *Oil-cakes*.—Oil-cakes are always known as very important concentrates for cattle. Their mineral constituents are given in Table X.

TABLE X.

Oil-cakes.

	Safflower.		Ground-nut cake (Arachis-hypogaea).	Til or Sesamum (Sesamum indicum).	Linseed (Linum usitatissimum).	Cotton seed (Gossypium).		Niger (Guizotia abyssinica).	Kopra (Cocos nucifera).	Rape seed.	Mustard seed.	Jambho cake.
	Undecor-ticated.	Decor-ticated.				Undecor-ticated.	Decor-ticated.					
	Carthamus tinctorious.											
	Per cent. on oven dry matter.											
Total ash	5.84	4.98	6.38	5.99	3.84	5.65	4.88	5.98	3.82	8.34	5.86	7.56
Acid insoluble (Silicious matter).	2.20	0.11	0.16	1.39	0.18	0.80	0.10	1.68	0.10	2.41	0.82	2.51
Acid soluble matter ...	3.64	4.87	6.22	4.60	3.66	4.85	3.78	4.30	3.72	5.93	5.04	5.05
Containing—												
Iron (Fe_2O_3) ...	0.19	0.04	0.32	0.06	0.22	0.24	trace	0.10	0.09	0.18	0.05	0.08
Lime (CaO) ...	0.15	0.08	0.06	0.09	0.14	0.38	0.12	0.12	0.21	0.22	0.08	0.18
Phosphoric Acid (P_2O_5)...	1.26	2.30	1.69	1.65	1.42	1.04	1.84	1.88	1.70	1.18	2.10	1.14
Potash (K_2O) ...	1.12	1.60	1.86	1.42	1.39	1.62	1.42	1.76	1.82	1.26	1.28	1.82
Water soluble chlorides as Sodium Chloride.	0.05	.....	0.46	0.22	0.12	.....	.....	.....	.....	0.06	0.08	0.12

(B) *Brans and husks*.—Besides oil-cakes which are residues from oil-seeds there are other residues from grains such as brans and upper covers of grains used as cattle feeds. These include:—1 *Tur phol* (cover of grain), 2 *Tur chuni* (bits of broken grains), 3 *Gram phol*, 4 *Gram chuni*, 5 *Wheat bran*, and 6 *Rice bran*.

TABLE XI.

	Tur Phol.	Tur Chuni.	Gram Phol.	Gram Chuni.	Wheat bran.	Rice bran.
	Per cent. on ovendry matter.					
Total ash	2.96	5.82	5.41	4.71	5.92	21.01
Acid insoluble	0.18	1.20	0.94	1.27	0.52	18.00
Acid soluble	2.78	4.62	4.47	3.44	5.40	3.01
Containing—						
Iron (Fe_2O_3)	0.45	0.81	0.22	0.36	0.19	0.11
Lime (CaO)	0.12	0.28	1.64	0.23	0.19	0.10
Phosphoric acid (P_2O_5) ...	0.14	1.01	1.11	1.22	2.81	1.53
Water soluble chlorides as Sodium Chloride.	0.05	0.15	0.13	0.22	0.66	0.12

(C) *Cultivated fodders*.—Only five of the cultivated fodders have been analysed for their mineral constituents. They are:—1 *Nilwa* (*Sorghum*), 2 *Lucerne* (*Medicago sativa*), 3 *Guinea grass* (*Panicum maximum*), 4 *Maize fodder* (*Zea mays*) and 5 fodder from green chavli (*Vigna catiang*) and 6 *Soya bean*.

TABLE XII.

Cultivated fodders.

	<i>Nilwa.</i>	Lucerne.	Guinea grass.	Maize fodder.	Berseem.	<i>Chavali</i> fodder.	Soya bean fodder.	Sugarcane tops.
			Per cent. on oven dry matter.					
Total mineral matter ...	9.13	14.44	16.95	7.83	16.29	16.80	20.31	8.19
Acid insoluble ...	7.07	0.95	7.88	2.62	1.88	5.88	10.81	3.50
Acid soluble ...	2.06	13.49	9.07	5.21	14.41	10.92	9.50	4.69
Containing—								
Iron (Fe_2O_3) ...	0.04	0.27	0.19	0.28	0.74	1.23	1.31	0.20
Lime (CaO) ...	0.23	2.04	1.00	0.46	1.24	1.99	1.99	0.04
Phosphoric acid (P_2O_5) ...	0.40	1.31	0.48	0.78	0.88	0.88	0.81	0.07
Water soluble chlorides calculated as Sodium Chloride.	0.20	0.92	2.38	1.10	0.98	0.62	0.19	0.81

(D) *Fodder leaves*.—Some of the important leaves commonly used as fodder were analysed for their mineral contents and they gave figures mentioned in the table below :—

TABLE XIII.

Fodder leaves.

			<i>Shevri leaves.</i>	<i>Nim leaves.</i>	<i>Bor leaves.</i>	<i>Babul leaves.</i>	<i>Pongara leaves.</i>
			Per cent. on	Per cent. on	Per cent. on	Per cent. on	Per cent. on
			ovendry	ovendry	ovendry	ovendry	ovendry
			matter.	matter.	matter.	matter.	matter.
Total mineral matter	...	...	5.44	13.75	9.64	7.53	14.50
Acid insoluble	...	...	0.25	1.26	1.00	0.05	0.20
Acid soluble	...	...	5.19	12.49	8.64	7.48	14.30
Containing—							
Iron (Fe_2O_3)	...	...	0.15	0.15	0.12	0.04	0.08
Lime (CaO})	...	...	0.75	5.29	3.57	2.51	3.63
Phosphoric acid (P_2O_5)	...	...	0.58	0.36	0.83	0.34	0.48
Water soluble Chlorides calculated as sodium chloride.			0.62	0.31	0.60	0.40	0.24

These are quite good in total mineral matter and in Phosphoric acid and are rich in lime.

We are thankful to Mr. N. R. Gurjar who helped us in carrying out some of the above analyses.

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