Role of Amlaki (Emblica Officinalis Linn.) In Experimental Ulcer

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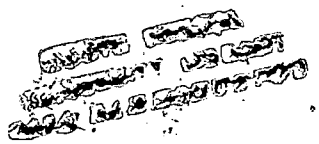

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I certify that Prasanta Kumar Mitra has worked under my guidance in the Centre for Life Sciences, University of North Bengal for his Ph.D. thesis entitled "Role of Amlaki (Emblica officinalis L.) in experimental ulcer". I am forwarding his thesis for the Ph.D. degree (Science) of the University of North Bengal.

I recommend that he has fulfilled all the requirements according to the rules of the University of North Bengal regarding his Research work.

(P.K.Basu)
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sb/

- " THIS WORK

IS

D E D I C A T E D

TO MY

BELOVED MOTHER "-

F O R E W O R D

The work embodied in this thesis submitted for the degree of Doctor of Philosophy (Science) of the University of North Bengal relates to the role of amlaki (Emblica officinalis Linn.) in experimental ulcers.

While presenting the work, I would like to express my deepest gratitude to Dr. P. K. Basu, Professor and Head, Department of Botany, Centre for Life Sciences, North Bengal University for his helpful suggestions and guidance in course of this investigation.

I am also thankful to all the teachers and research scholars of the Centre for Life Sciences, North Bengal University; Prof. A. K. Sanyal, Department of Pharmacology, Institute of Medical Sciences, Banaras Hindu University and the staff of

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Prasanta Kumar Mitra

(PRASANTA KUMAR MITRA)

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INTRODUCTION

I N T R O D U C T I O N

Peptic ulcer, because of its frequency and worldwide distribution, continues to be the subject of numerous investigations both experimental and clinicopathological. In this respect peptic ulcer occupies a place secondary to carcinoma in the field of gastroenterology. Quincke[1] was probably the first to use the term 'peptic ulcer' which is an excoriated area of gastroduodenal mucosa caused by the digestive actions of gastric juice.

PATHOGENESIS OF PEPTIC ULCER

Physiologically, peptic ulcer results from the inability of the localised area of gastroduodenal mucosa to withstand the digestive action of acid-pepsin of gastric content. Quincke[1] stressed the importance of acid and pepsin in the aetiology of peptic ulcer. Schwarz[2], Kahn[3], Palmer and Nutter[4] suggested that peptic ulcer does not occur in absence of acid. Menguy[5] as well as Glass[6] described the

importance of mucus in preventing the gastric mucosa from forming ulcers. Clinical experience has suggested that the cause may be multiple and may include anxiety, smoking and fatigue as enviornmental factors with the parietal cell mass and the blood groups as helping to determine the hereditary tendency[7]. In addition to these factors there are many other important factors which need consideration in the pathogenesis of peptic ulcer, viz., mucosal blood flow[8-10], neurohumors and autocoids[11-14], autonomic nervous system[15,16], gastro-intestinal hormones[17-20] and central nervous system[21,22]. Thus it signifies that the pathogenesis of peptic ulcer has long been a matter of investigation and debate, nor has any agreement yet been reached in spite of extensive research in this direction.

EXPERIMENTAL ULCER

So far as experimental ulcer is concerned, it was Seyle[23] who for the first time developed gastric ulcer in albino rats subjected to different types of noxious stimuli. Brodie and Hanson[24] produced stress induced gastric ulcers in various experimental animals and implicated increased acidity in the pathogenesis of these ulcers. Bonfils and Lambling[25] as well as Guth and Hall[26] suggested the importance of disturbed circulation in experimental restraint ulcer. Now-a-days, it is well known that ulcer can be produced in rats, guineapigs and mice by injecting various drugs viz. analgesic, antipyretic, antiinflammatory, steroids, ACTH, histamine etc.[27,28]

ASPIRIN INDUCED GASTRIC ULCERATION

Anderson[29] and Davidson *et al.*[30] have demonstrated that parenteral administration of aspirin does not produce

gastric haemorrhage in animals or man, while other workers have shown that direct contact of aspirin with gastric mucosa is not necessary for the production of gastric bleeding[31-33]. Brodie and Chase[34] and Djahanguiri[35] reported that subcutaneous or intraperitoneal injection of aspirin produced 90-100% ulcerogenic response in rats. Furthermore, Brodie and Chase[34] showed dose dependent response of aspirin by oral or intraperitoneal route.

The literature on the effect of aspirin on gastric secretion was reviewed by Lynch et al.[36], who reported an increase, no change or a decrease in gastric secretion by salicylates depending upon the preparations and species studied. Paul et al.[37] and Lish et al.[38] have reported that aspirin caused decrease in volume and acidity of the gastric secretions in rats. Winkelman and Summerskill[39] reported that aspirin given by mouth in customary doses has no effect on hydrochloric acid secretion. Soluble aspirin acted as a weak stimulus whereas sodium salicylate solution appeared to inhibit secretion. Furthermore, they suggested that in the pathogenesis of aspirin induced gastric ulceration factors involved in mucosal damage and resistance seem to be more important than hydrochloric acid secretion. Aspirin may also increase epithelial cell exfoliation[40], reduce the secretion of mucus[41] and alter its composition[42] and physiochemical properties[43].

Davenport[44-45] has presented a hypothesis on mechanism of aspirin induced gastric damage. He suggested that aspirin alters the gastric mucosa in some way which permits the back diffusion of hydrogen ion through the normally impermeable mucosa into the interstitial space, where it causes capillary breakdown and haemorrhage. Thus the low gastric acidity by aspirin is due to loss of hydrogen ion

through the gastric mucosa rather than to a suppression of parietal cell activity.

Aspirin has also been shown to reduce the rate of synthesis and secretion of mucus[41,42]. It seems possible as Menguy[41] suggested that it is the loss of mucus 'barrier' that permits the back diffusion of hydrochloric acid into the aspirin-damaged gastric mucosa. Davenport[44] showed that aspirin damaged gastric mucosal barrier which allows back diffusion of hydrogen ion. When the mucosa is damaged by salicylates histamine is released and capillary permeability increases which is followed by bleedings.

Brodie and Chese[34] observed that aspirin-induced gastric ulcerations were significantly reduced by anticholinergic, antacids, a ganglion blocking agent and vagotomy but not by central nervous system depressants. Djahanguiri[46] reported the involvement of catecholamines in aspirin-induced gastric ulceration. Caravati and Cosgrove[47], Dodd et al.[48] have suggested central role of salicylates induced gastric ulceration and haemorrhage by hypothalamic-pitutary-adrenal system. Salicylates mimic in many respects the pharmacological properties of cortisone[49], but the evidence is conflicting regarding the release of cortisone by the action of salicylates on the pitutary-adrenal axis[50]. Smith[50], in a comprehensive review of the subject, has concluded that the majority of effects of salicylates are due to their intrinsic properties rather than to secondary endocrine influences.

ANALGIN AND PARACETAMOL INDUCED GASTRIC ULCERATION

Peracetamol (acetaminophen) and analgin (metanizol or dipyrene or sodium noramidopyrine methanesulphonate or noraminopheno-

-zone) are generally thought to be safe antipyretic and analgesic having antiinflammatory activities too. Paracetamol was originally used in the late 19th century, but only in the last few years it is again widely used as an antipyretic and analgesic agent. Adverse effects following therapeutic doses have rarely been recorded. Proudfeet and Wright[51] studied 41 cases of acute paracetamol poisoning in which only one died of gastrointestinal haemorrhage and acute massive necrosis of the liver, which on autopsy showed massive upper alimentary bleeding due to hypoprothrombinaemia. However, analgin has been shown to cause agramulocytosis as a serious toxic effect[52,53].

GLUCOCORTICOIDS INDUCED GASTRIC ULCERATION

Numerous reports are there showing glucocorticoids, viz. hydrocortisone, cortisone, prednisolone and ACTH produce gastric ulceration in normal rats[54,55], the shay rats[56], dogs[57,58] and in man[59,60]. Kahn et al.[61] have reported extension and perforation of the ulcers as well as reulceration of a healed ulcer area in rats receiving cortisone.

Several theories have been proposed to explain the pathogenesis of glucocorticoid induced gastric ulceration. Robert and Nezamis[54] have found that anticholinergic drug methscopolamine bromide prevents the steroid induced ulcers. Robert and Nezamis[62,63] suggested that the antipolgistic property of steroid may be concerned for gastric ulceration. Seyle[64] suggested the diminution of tissue resistance related to the anti-inflammatory action of corticosteroids in the genesis of ulceration. Foley and Glick[65] and Robert and Nezamis[62,63] have suggested the role of histamine release in corticoid induced gastric

ulceration. Levis and Beersaerts[66] observed vascular dilation resulting in localized haemorrhagic thrombosis in corticoid induced gastric ulceration. Sanyal and coworkers[28,67] reported that anti 5-HT agent (Cyproheptadine) failed to prevent prednisolone induced gastric ulcers, whereas banana extract reduced the incidence.

INDOMETHACIN INDUCED GASTRIC ULCERATION

Indomethacin was introduced in 1962 as a synthetic non-steroidal, anti-inflammatory, analgesic and anti-pyretic agent for the treatment of rheumatoid arthritis, degenerative joint-disorders and other inflammatory conditions. Reported observations suggested that patients taking indomethacin sometimes developed gastrointestinal symptoms[68-70].

That indomethacin caused peptic ulcer in human subjects was reported by Wanke et al.[71] and Kais et al.[72] while Ballabio[73] found no evidence of ulcer but only bleeding in patients taking indomethacin as therapeutic agent, although the site and the pathogenesis of haemorrhage remains a mystery.

In animal experiments, Djahanguiri[74] and Lee et al.[75] showed that indomethacin caused gastric, duodenal, antral and jejunal ulcerations, haemorrhage and perforation in rats and guineapigs. On studing this ulcerogenic property, Nocolff[76] showed that ulcerogenic effect of indomethacin did not seem to be related to acid hypersecretion Menguy[41], however, while studing the mucus secretion in vagally denervated gastric antral pouch of dogs during administration of indomethacin for 21 days showed that indomethacin lowered the rate of secretion of gastric antral mucus and diminished the amount of

carbohydrate incorporation into the mucosubstance.

PHENYLBUTAZONE AND OXYPHENBUTAZONE INDUCED GASTRIC ULCERATION

A non-steroid, synthetic compound 'phenylbutazone' was introduced in 1949 for the treatment of rheumatoid arthriti musculoskeletal diseases and allied disorders. Mauer[77] in a survey of 3934 patients treated with phenylbutazone reported 40 proved cases of peptic ulcers, 9 cases of haemorrhage and an additional 424 individuals also developed gastrointestinal symptoms including epi-gastric pain. Others who reported development of peptic ulcer after constant use of phenylbutazone were Leonard[78], Deseze and Levernievx[79], Kern et al[80] and Kirsner[81].

Animal experimental studies also showed that mice, rats, guineapigs and dogs were vulnerable to peptic ulceration after phenylbutazone treatment administered either orally or parenterally.[82-84]

A casual relationship between phenylbutazone ulcers with gastric secretion and acidity was observed by various workers. Schimid et al.[85] reported that phenylbutazone stimulated both gastric acid secretion and peptic activity of the gastric juice, oxyphenbutazone, by contrast, lacked these effects. Bonfils[86] observed that there was no change in gastric acid secretion after oral or parenteral administration of the drug. Number of workers, however, have given importance to the mucus barrier whose absolute or relative deficiency acts as a factor in the production of ulceration[87-90]. Zaidi et al.[91] observed a steady decrease of mucin in the gastric juice after 30 days of phenylbutazone treatment in guineapigs.

STRESS INDUCED GASTRIC ULCERATION

Several studies in human subjects have demonstrated that emotion can cause increase in gastric acidity. On this basis 'emotional stress' has been considered as an important factor in the etiology of peptic ulcer. James[92] discussed the work of Wolf and Wolf on fistulous patient. He showed that when the patient was subjected to acute or chronic periods of emotional stress there was an increase in the gastric acidity. Shay and Coworkers[93] demonstrated that the emotional stress increased the total acid output to over four times the basal levels. Eichhorn and Trackfier[94] observed alteration in acid secretion in patients with hypnotically-induced emotions. Thus it appears that emotional stress can be a factor in the etiology of peptic ulcer.

Seyle[23] was the first to report the experimental peptic ulcer in rats subjected to different types of noxious stimuli such as immobilization, injection of drugs, exposure to cold or surgical trauma. Since then many other workers reported the restraint ulcers in rats by immobilization[24,95]. These stimuli were classified as nonspecific stressee. It was postulated that nonspecific stresses produced certain emotional disturbances in the animals, which increase adrenal function and resulted into the appearance of 'neurogenic' ulcer in 85-100% animals. Behavioral techniques for the production of neurogenic ulcers have been described in rats by Weisz[96] and in monkey by Porter et al.[97] They used conflict situation in the animals by electrical shock, anxiety, punishment and condition avoidence situation.

Numerous studies have been undertaken to

investigate the mechanism underlying the stress induced gastric ulceration[27,93]. Menguy[27] was first to demonstrate the effects of restraint on gastric secretion in the pyloric-ligated rats. He demonstrated that restraint significantly decreased free acid output in these animals, although vagotomy prevented the restraint ulcers. Thus, he concluded that acid-pepsin digestion was not the basic mechanism in the production of restraint ulcers. The protection provided by vagotomy was due to an alteration in gastric mucosal blood flow or delayed gastric emptying. Brodie et al.[24,98] studied the effects of restraint on gastric secretion in the chronic fistula rat. They found increase in the concentration of free and total acid. It is not necessary, James pointed out[92], that stress alters gastric secretion mediated through vagus nerve. Gray[99] has reviewed the effects of endocrine changes on gastro-intestinal tract and indicated that gastric acidity can be increased by adrenocortical stimulation. Bonfils and Lambling[25] and Guth and Hall[26] suggested the importance of disturbed circulation in restraint rats. Nylander and Olerud[100] observed the accumulation of blood vessels just beneath the surface of epithelium after 6h restraint. 'The vascular engorgement and ulceration were prevented by vagotomy' - observed by Guth and Kozbur[101] who demonstrated that buffering of intraluminal contents does not prevent microcirculatory and meat cell changes associated with restraint, but produces a decrease in the incidence of ulceration. However, Goldman and Rosoff[102] showed that the vascular changes occur before the appearance of gastric lesions. Hase and Moss[103] studied the microvesicular changes in gastric mucosa in the development of stress ulcers in the rats. They suggested that mucosal ischaemia is caused by contraction of connecting arterioles and that persistent local ischaemia of gastric mucosa triggers tissue damage and development of stress ulcers.

Sharma et al.[104] suggested that hypothalamus may be concerned in relaying effects of stress to stomach both by neural and hormonal routes. Several investigators have demonstrated that vagotomy reduced the incidence of restraint ulcers[24,95,105]. Furthermore, Hanson and Brodie[24] and Hanson[106] showed that pretreatment with anticholinergic drugs, viz. atropine or scopoeminemethylbromide prevents the ulcer formation in restrained rats.

There are reports that stress induced gastric ulceration is primarily due to excitation of sympathetic nervous system which leads to increase in the turnover rate of catecholamines in the gastric mucosa[46]. Okabe et al.[107] and Djahanguiri et al.[46] have reported that alpha adrenoceptor blockers (phentolamine, phenoxybenzomine dibenamine and yohimbine) and beta adrenoceptor blockers (propranolol and aleprenol) reduce the incidence of gastric ulceration induced by stress. On the contrary, Djahanguiri et al.[35] reported that beta adrenoceptor blockers failed to prevent stress induced gastric ulcers. However, Takagi et al.[108] showed that propranolol in doses of 1 mg/kg aggravates stress ulcers but when the dose of propranolol was increased to 10 mg/kg it blocks the ulcers. It has also been shown that the drugs bretylium and alpha methyl dopa which deplete or alter the synthesis of catecholamines block stress ulcer[46]. However, these workers failed to protect stress-induced gastric ulceration by 6-hydroxydopamine which causes chemical denervation of sympathetic nerves. 'Stress ulcer is due to central sympathetic activation', Fledmen et al. suggested[109]. Corrodi et al.[110] have demonstrated that the stressful stimuli increase brain noradrenaline turnover and ACTH secretion. Recently, Bhargava et al.[111]

reported the involvement of catecholamines in the release of ACTH. There are many reports showing an increase in corticoids secretion during stress[112,113] and corticoids do cause gastric ulceration[55,56]. However, bilateral adrenalectomy failed to prevent restraint ulcers[24,46].

Many workers have attributed the role of histamine in restraint ulcers. Singh et al.[114] demonstrated increased level of blood histamine during stress. Alphin and Ward[115] failed to prevent stress induced gastric ulcers by classical antihistaminics (H_1 receptor blockers. Bugajski et al.[116] showed that restraint ulcers are blocked by metiamide which is an H_2 receptor blockers). Cyproheptadine which is an anti 5-HT failed to prevent restraint ulcers[67]. There are many reports that psychotrophic drugs prevent restraint ulcers. Bonfil and Lambling[25] showed that metaminodiazepoxide, thioproperazine and reserpine were ineffective in restraint ulcers. Imipramine in doses of 5 mg/kg failed to protect restraint ulcers but when the dose was increased to 10 and 20 mg/kg, the protection was proportional to the dose.

Thus, it seems that both local and systemic factors are involved in stress-induced gastric ulceration. In the local factors, gastric environment, mucus secretion, vascular alteration and cellular resistance are important[117,118]. Systemically, the stimulation of CNS , presence of high level of catecholamines and histamine may play an important role during stress.[46,114,119]

TREATMENT OF PEPTIC ULCER : ROLE OF INDIAN MEDICINAL PLANTS

Due to scant and contradictory knowledge about the cause of peptic ulcer, its treatment is still unspecific. Apart from the successful intervention of surgical means, drugs most frequently

used are either antacids, anticholinergics or the pro-mucus secreting drugs depending on the type and sign-symptoms of the ulcers. At present prostaglandin E_1 shows some therapeutic importance in peptic ulcer although it is still under trial[120].

Treatment of peptic ulcer with Indian medicinal plants and fruits is now attaining considerable interest to researchers. Senyal et al.[28,121] showed both the prophylactic action and the curative value of unripe vegetable banana in different types of experimental ulcers. Elliot and Heward observed[122], unripe banana prevents histamine induced gastric ulcer in mice. Recently, Varma et al.[123] demonstrated that amlaki rasayana, an indigenous medicine main ingredient of which is amlaki, is efficacious in patients suffering from gastritis and hyper acidity.

We in our laboratory when screened a number of indigenous plants and fruits for their antiulcerogenic activity[124-126] noticed that amlaki (Emblica officinalis Linn.) exerted antiulcerogenic effects in experimental ulcers as induced by

a. Aspirin

b. Restraint stress.

Since two experimental models are not sufficient to evaluate the antiulcerogenic activity of amlaki, it was thought worthwhile to study the same in more experimental ulcer models. The present work, thus, was an attempt to evaluate the antiulcerogenic property of amlaki and its effect on various biochemical profiles in experimental ulcers.

PLAN OF RESEARCH WORK

PLAN OF RESEARCH WORK

The work embodied in the thesis covers the studies on the role of amlaki (Emblica officinalis Linn.) in experimental ulcers. Experimental ulcers were induced in animals by various ulcerogenic drugs/methods and effect of amlaki (Emblica officinalis Linn.) on these ulcers was studied. The following scheme of work was followed in course of the investigations.

Chapter I : DEVELOPMENT OF EXPERIMENTAL ULCERS : ROLE OF AMLAKI (Emblica officinalis Linn.

a) Development of peptic ulcers in rats by the drugs like,

1. Aspirin
2. Salicylic acid
3. Paracetamol
4. Indomethacin

5. Prednisolone

6. Hydrocortisone

by the methods like,

7. Restraint

8. Shay

in guinea-pigs by the drug

9. Phenylbutazone

and in mice by the drug

10. Histamine.

b) Evaluation of antiulcerogenic property of amlaki (Emblica officinalis Linn.) in these experimental ulcer models.

Chapter - II : STUDIES ON ACID-PEPTIC FACTOR : ROLE OF AMLAKI (Emblica officinalis Linn.)

Collection of gastric juice and determination of its rate of secretion, acidity and peptic activity during ulceration as well as after treatment with amlaki (Emblica officinalis Linn.).

Chapter - III : STUDIES ON DISSOLVED GASTRIC MUCIN : ROLE OF AMLAKI (Emblica officinalis Linn.)

Analysis of dissolved gastric mucin

by estimating its constituent carbohydrate components like, total hexose, hexosamine, methyl pentose and sialic acid during ulceration as well as after treatment with amlaki (Emblica officinalis Linn.).

Chapter - IV : STUDIES ON GASTRIC MUCOSAL MUCUS : ROLE OF AMLAKI (Emblica Officinalis Linn.)

Isolation of gastric mucosal mucus and its analysis during ulceration as well as after treatment with amlaki (Emblica officinalis Linn.).

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Chapter - I

DEVELOPMENT OF EXPERIMENTAL ULCERS : ROLE OF AMLAKI (*Emblica officinalis* Linn.)

C H A P T E R - I

To evaluate the antiulcerogenic property of amlaki (Emblica officinalis Linn.) experimental ulcers were produced in animals by known ulcerogenic drugs as well as methods like restraint stress, Shay technique etc. and the effect of amlaki diet on such ulcers was observed.

E X P E R I M E N T A L

ANIMAL : Experiments were conducted on healthy albino rats (80 - 140g) albino mice (25 - 30g) and guinea-pigs (400 - 700g) of either sex.

DRUGS AND SOLUTIONS :

a) Pentobarbital sodium (Nembutal, Abbot) : 1.0% solution in distilled water was prepared fresh at the time of use.

b) Anesthetic ether (Industrial solvents and chemicals).

c) Mepyramine maleate (May & Baker).

d) Histamine acid phosphate (Evan Medical).

e) Phenylbutazone sodium (Butazolidine, Geigy) : 40 mg/ml solution in distilled water was prepared fresh at the time of use.

f) Aspirin (Indosel Chemical Corporation) : 30 mg/ml suspension was made in olive oil fresh at the time of use.

g) Salicylic acid (Alta Laboratory) : 30 mg/ml suspension was made in olive oil fresh at the time of use.

h) Indomethacin (Indocid, Merck Sharp and Dohme) : 5 mg/ml suspension in distilled water was prepared fresh before injection.

i) Paracetamol (East India Pharmaceutical) : 30 mg/ml suspension was made in distilled water fresh at the time of use.

j) Prednisolone acetate (Deltacortil, Pfizer) : Stock solution supplied in the viale of 20 mg/ml was used.

k) Hydrocortisone (Roussel Pharmaceutical) : Stock solution supplied in viels of 25 mg/ml was used.

DRUGS / METHODS FOR INDUCTION OF ULCER : (Table - P)

Drugs/ Methods.	Animals	Dose of drugs.	Route of injection/ administration.	Reference
Aspirin	Rat	100 mg/kg	Intraperitoneal.	Djahanguri 74

Table - P (Contd.)

Drugs/ Methods.	Animals.	Dose of drugs.	Route of injection/ administration.	Reference.
Salicylic acid	Rat	100 mg/kg	Intraperitoneal.	Djahanguri.[74]
Indomethecin	Rat	25 mg/kg	Intraperitoneal.	Lee et al.[75]
Paracetamol	Rat	100 mg/kg	Intraperitoneal.	Rem.[127]
Prednisolone	Rat	30 mg/kg	Intraperitoneal.	Robert & Nezamis.[56]
Hydrocortisone	Rat	50 mg/kg	Intraperitoneal.	
Phenylbutezone	Guineapig	100 mg/kg	Oral.	Sanyal et al.[121]
Histamine	Mice	33 /ug/mouse	Intraperitoneal.	Elliott & Heward.[122]
Restraint	Rat	-	-	Menguy.[27]
Shay	Rat	-	-	Shay et al.[128]

AMLAKI : Sundried amlaki powder was used as the test drug. Green amlaki (Emblica officinalis Linn.) was purchased from the local market, cut into slices, sundried and powdered in a crusher.

DRUGS INDUCED ULCERS : EFFECT OF AMLAKI (Emblica officinalis Linn.)

Rats/ guineapigs/ mice under study were divided into three groups :

Drug : When the animals were acclimatized with laboratory conditions drug(in specific dose for specific animal)was given to them through specific route as mentioned in Table - P at about 9 a.m. once in a day for consecutive three days.These days the animals

took normal diet and water. All the animals received the drugs in the same way either by intraperitoneal injection or through oral route with the help of a fine catheter (Phenylbutazone group for guineapigs) only in the case of histamine group mice received an additional intraperitoneal injection of mepyramine maleate in the dose of 2.5 /ug/mouse 20 minutes before the histamine injection. This was to protect the animals from the potentially lethal effects of large dose of histamine necessary to produce gastric ulcers.[122]

After giving the third dose of ulcerogenic drug, animals were kept on fasting for a period of 24 hours when no food but water was supplied ad libitum. When the fasting period was over, animals were anaesthetised with pentobarbitone sodium (40 mg/kg) , abdomen opened and the pyloric end of the stomach was ligated avoiding nearby vessels and nerves. Abdomen was then closed and the animals left in cages for a period of 4 hours when water was withheld. Duration of anaesthesia and operative technique were same for all animals,discussed above as suggested by Sanyal et al.[129]

After 4 hours the animals were sacrificed with ether, abdomen opened and the stomach was exposed. The cardiac end was ligated and the stomach was dissected out, freeing it from all of its attachments. The content of the stomach was evacuated into a centrifuge tube and centrifuged for 10 minutes at 3000 x g. The supernatant was collected and utilized for the subsequent studies (For Chapters II and III).

Evacuated stomachs were then opened along the

greater curvature, carefully washed with water, examined macroscopically and microscopically for the presence of ulcer and kept for subsequent studies (For Chapter IV).

Drug and amlaki : Sundried amlaki (Emblica officinalis Linn.) powder in the dose of 1 g/kg of body weight was given to the animals orally with the help of a fine catheter once in a day for consecutive three days alongwith the ulcerogenic drugs and normal diet. When the third dose of amlaki was over, animals were kept on fasting for a period of 24 hours when no food but water was supplied ad libitum. Rest experimental procedure was same as that of 'Drug' group.

Control : Random controls, received three successive injections of vehicles of drugs, were kept on fasting for a period of 24 hours when no food but water was supplied ad libitum . Rest experimental procedure was same as that of ' Drug ' group.

RESTRAINT ULCER : EFFECT OF AMLAKI (Emblica officinalis Linn.).

Rats under study were divided into three groups :

Restraint : Healthy rats were first acclimatized with laboratory conditions and then kept on fasting for a period of 18 hours when no food but water was supplied ad libitum. After fasting period,

under light ether anaesthesia, rats were placed in a restraining jacket of fine mesh wire. Their paws, protruding through holes in the wire, were immobilized with adhesive tape. The animals were then suspended individually from laboratory stands for 20 hours as described by Menguy[27].

After 20 hours of stress, rats were operated for p pylorus ligation and 4 hour gastric secretion was collected. Duration of anaesthesia, technique of operation, collection of gastric juice and examination of stomach for the presence of ulcers were essentially same as discussed in the experimental part of 'Drug Induced Ulcer'.

Restraint and amleki : Sundried amleki (Emblica officinalis Linn.) powder in the dose of 1 g/kg of body weight was given to healthy rats with the help of a fine catheter once in a day for consecutive three days in addition to normal diet and water. Animals were then kept on fasting for 18 hours when no food but water was supplied ad libitum. Rest experimental procedure was same as that of 'Restraint' group.

Control : Random controls were kept on fasting for a period of 18 hours when no food but water was supplied ad libitum. After fasting period, under light ether anaesthesia, rats were placed in individual metabolic cages without giving any stress, food and water for 20 hours Rest experimental procedure was same as that of 'Restraint' group.

SHAY ULCER : EFFECT OF AMLAKI (Emblica officinalis Linn.).

Rats under study were divided into three groups.

Shay :

Shay ulcers were produced in rats by the technique described by Shay et al.[128] Rats were first acclimatized with laboratory conditions and then kept on fasting for 48 hours when no food but water was supplied ad libitum. After this period, rats were anaesthetised with pentobarbitone sodium (40 mg/kg), abdomen opened and pylorus ligated avoiding nearby vessels and nerves. Abdomen was then closed and the animals were kept in cage for 16 hours when water was withheld. After this period, rats were sacrificed with ether, abdomen opened and accumulated gastric juice was collected and stomachs were examined for the presence of ulcers by the techniques as described in the experimental part of 'Drug Induced Ulcer'.

Shay and amlaki :

Sundried amlaki (Emblica officinalis Linn.) powder in the dose of 1 g/kg of body weight was given to rats orally with the help of a fine catheter once in a day for consecutive three days in addition to normal diet and water. Animals were then kept on fasting for 48 hours when no food but water was supplied ad libitum. Rest experimental procedure

was same as that of 'Shay' group.

Control : Random controls were kept on fasting for a period of 24 hours when no food but water was supplied ad libitum. After fasting period, rats were anaesthetised with pentobarbitone sodium (40 mg/kg), abdomen opened and pylorus ligated avoiding nearby vessels and nerves. Abdomen was then closed and the animals were kept in cage for 4 hours when water was withheld. After this period, the animals were sacrificed with ether, accumulated gastric juice collected and the stomachs were examined for ulcers, if any, by the techniques described in experimental part of 'Drug Induced Ulcer'.

Animals died in any group during the course of experiment were immediately separated, abdomen opened, stomach dissected out and examined for the presence of ulcers, if any.

ULCER INDEX :

Ulcer index was calculated following the method described by Robert et al.[130] Each and every stomach was examined with the help of a magnifying glass and ulcer index was scored for the group as the sum of the followings :

a. Percentage incidence (divided by number of animals) of animals with ulcers.

b. Average severity per group scored in pluses (From a scale of 0 to 4+) and

c. Average number of ulcers per stomach (The presence of at least one area of erosion of the gastric mucosa was taken as the criterion for positive appearance of ulcer).

Evaluation of pathology was always by the 'blind' method.

R E S U L T S

Results are given in and from Table 1 to Table 10.

Aspirin induced ulcer : Effect of amlaki (Emblica officinalis Linn.)

Table 1 shows the effect of amlaki (Emblica officinal Linn.) on aspirin induced peptic ulcers in albino rats. All the animals received aspirin (100 mg/kg/day for consecutive three days, intraperitonially) developed ulcers in glandular portion of stomach, some of which were superficial in nature while the others were penetrating ulcers. Ulcerated stomach was invariably accompanied with frank intragastric haemorrhage. Microscopically, there was erosion of the mucosa, dilatation and congestion of the blood vessels and sometimes oedema of the mucosal and submucosal layers. 5 animals out of 30, died during experiment, showed the presence of deep penetrating ulcers in the stomachs.

In the amlaki-fed rats (1g/kg/day for consecutive three days alongwith aspirin through oral route) small ulcers were found present in only 31.2% of the animals. Some of these rats (15.6% of the total animals) had also frank intragastric haemorrhage. In all other rats of this group either the stomach showed microscopically

TABLE : 1. Showing the effect of amlaki (*Emblica officinalis* Linn.) on aspirin induced peptic ulcers in albino rats.

Group	Dose used	No. of animals.	Animals with ulcers		Animals with haemorrhage		Other features	Ulcer index
			No.	%	No.	%		
CONTROL	-	25	Nil	Nil	Nil	Nil	Nil	Nil
ASPIRIN	100 mg/kg.	30 (5)	30	100	30	100	Adhesion in 7, Perforations in 5,	23.1
ASPIRIN + AMLAKI	100 mg/kg. 1g/kg	32 (2)	10	31.2	5	15.6	Ulcers were attempting to heal as shown by more fibrosis and thickening.	11.2

Brackets in perenthesis indicate the no. of animals died during experiment.

normal appearance or slight vascular dilatation or the evidence of attempting to heal the ulcers. 2 rats out of 32, died during experiment, showed the presence of few penetrating ulcers in the stomachs.

Salicylic acid induced ulcer : Effect of amlaki (Emblica officinalis Linn

Result of Effect of amlaki (Emblica officinalis Linn.) on salicylic acid induced peptic ulcers in albino rats was given in Table 2. Salicylic acid in the dose of 100 mg/kg/day when given intraperitonially to the rats once in a day for consecutive three days produced ulcers in the glandular part of stomach. All the animals received salicylic acid developed ulcers which were mainly superficial in nature. Few penetrating ulcers were also present. Frank intragastric haemorrhage was noticed in all the ulcerated stomachs. In this group there were 32 animals out of which adhesion was found in 5 animals while 4 animals showed acute dilatation of the blood vessels. Oedema of the mucosal and submucosal layers was also observed in some animals. 6 animals out of 32, died during experiment, showed the presence of either perforation or deep penetrating ulcers. Ulcer index when calculated gave the value 24.

In amlaki-fed group 30 animals were employed. Out of 30, 10 animals (33.3%) showed the presence of small ulcers in glandular part of the stomach. 5 animals (16.6%) had intragastric haemorrhage and the ulcers were attempting to heal as shown by more fibrosis and thickening. All these corresponded to the ulcer index 13.4 . 3 animals out of 30, died during experiment, showed the presence of penetrating ulcers in the stomachs. In other animals, stomachs showed microscopically normal appearance.

TABLE - 2 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on salicylic acid induced peptic ulcers in albino rats.

Group	Dose used	No. of animals.	Animals with ulcers.		Animals with haemorrhage.		Other features.	Ulcer index.
			No.	%	No.	%		
CONTROL	-	30	Nil	Nil	Nil	Nil	Nil	Nil
SALICYLIC ACID	100 mg/kg	32(6)	32	100	32	100	Adhesion in 5, acute dilatation in 4, perforation in 3.	24.0
SALICYLIC ACID + AMLAKI	100 mg/kg 1g/kg	30(3)	10	33.3	5	16.6	Ulcers were attempting to heal as shown by more fibrosis and thickening.	13.4

Brackets in parenthesis indicate the no. of animals died during experiment.

Paracetamol induced ulcer : effect of amlaki (Emblica officinalis Linn.

Results are given in Table 3.

Paracetamol in the dose of 100 mg/kg/day when given intraperitonially to the rats once in a day for consecutive three days produced ulcers in the glandular part of stomach. Incidence of ulceration was found 100%. Ulcers were mainly superficial in nature although few penetrating ulcers were also present. Haemorrhage was noticed in 80% of the ulcerated stomachs. Microscopically, 4 ulcerated stomachs showed adhesion while in 3 acute dilatation was observed. 6 animals out of 35 (17.14%), died during experiment, showed the presence of deep penetrating ulcers. In one animal perforation was observed.

When amlaki (Emblica officinalis Linn.) was given orally to the rats in the dose 1 g/kg/day once in a day for consecutive three days alongwith paracetamol in the dose stated above, incidence of ulceration was going down to 18.1%. Incidence of haemorrhage was also decreased to 24.2% . Ulcers which were still present were attempting to heal as shown by more fibrosis and thickening. In other rats, stomach showed microscopically normal appearance. 2 animals out of 33 (6%), died during experiment, showed perforation in the stomach. Ulcer index in this group was going down to 8.3 in comparison to 25 in paracetamol treated group.

Indomethacin induced ulcer : Effect of amlaki (Emblica officinalis Linn.)

Effect of amlaki (Emblica officinalis Linn.) on indomethacin induced peptic ulcers in albino rats was given in Table-4. Rats received indomethacin (25mg/kg, intraperitonially) once in a day

TABLE - 3 : Showing the effect of amlaki (Emblica officinalis Linn.) on paracetamol induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Animals with ulcers.		Animals with haemorrhage		Other features.	Ulcer index.
			No.	%	No.	%		
CONTROL	-	29	Nil	Nil	Nil	Nil	Nil	Nil
PARACETAMOL	100 mg/kg	35(6)	35	100	28	80	Adhesion in 4, acute dilatation in 3.	25
PARACETAMOL + AMLAKI	100 mg/kg 1 g/kg	33(2)	6	18.1	8	24.2	Ulcers were attempting to heal.	8.3

Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 4 : Showing the effect of amleki (Emblica officinelis Linn.) on indomethacin induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Animals with ulcers.		Animals with haemorrhage.		Other features.	Ulcer index.
			No.	%	No.	%		
CONTROL	-	26	Nil	Nil	Nil	Nil	Nil	Nil
INDOMETHACIN	25 mg/kg	28(2)	28	100	18	64.2	Perforations in 4, acute dilatation in 3, adhesion in 2.	27.5
INDOMETHACIN + AMLAKI	25 mg/kg + 1 g/kg	25(1)	5	20	5	20	Slight vascular dilatation in 3.	11.0

Brackets in parenthesis indicate the no. of animals died during experiment.

for consecutive three days developed ulcers in the glandular part of the stomach. Ulcers were found in all the animals. Ulcers were mainly superficial in nature although few deep ulcers were also found. In this group 28 rats were employed. 4 of them showed perforation in their stomachs, 3 had acute dilatation while adhesion was found in 2 animals. Frank intragastric haemorrhage was noticed in 18 ulcerated stomachs (64.2%). All these gave the ulcer index 27.5 . 2 animals in this group , died in course of investigation, showed perforation in the stomachs.

In amlaki-fed (amlaki (Emblica officinalis Linn.) was given orally in the dose of 1 g/kg/day once in a day for consecutive three days alongwith indomethacin in the dose stated above) group 25 rats were used. Out of these only 5 animals showed the presence of ulcers in glandular part of the stomach. Incidence was 20%. Ulcers were small, superficial in nature accompanied by frank intragastric haemorrhage. In 3 ulcerated stomach slight vascular dilatation was observed. Stomache of the rest animals showed microscopically normal appearance. Ulcer index for this group was found 11. Only 1 animal out of 25 (4%), died during experiment, showed the presence of several penetrating ulcers. Mortality rate of this group (4%) was comparable to that of indomethacin treated group (7.14%).

Prednisolone induced ulcer : Effect of amlaki (Emblica officinalis Linn.

Table 5 shows the effect of amlaki (Emblica officinal: Linn.) on prednisolone induced peptic ulcers in albino rats. When prednisolone (30 mg/kg) was given to rat intraperitonially once in a day for consecutive three days, ulcer was found formed in the glandular

TABLE - 5 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on prednisolone induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Animals with ulcers.		Animals with haemorrhage.		Other feetures.	Ulcer index.
			No.	%	No.	%		
CONTROL	-	30	Nil	Nil	Nil	Nil	Nil	Nil
PREDNISOLONE	30 mg/kg	33(4)	33	100	28	84.8	Adhesion in 10.	22.4
PREDNISOLONE + AMLAKI	30 mg/kg 1 g/kg	37(2)	10	27	10	27	Adhesion in 1.	8.2

Brackets in parenthesis indicate the no. of animals died during experiment.

portion of the stomach. Incidence of ulceration was 100%. Most of the ulcers were small, superficial in nature. A few big ulcers were also found, some of them were deep. 28 animals out of 33 of this group (84.8%) had frank intragastric haemorrhage in stomach. Adhesion was found in 10 rats. All these gave the ulcer index 22.4 . Mortality rate in this group was 12.12% and these animals showed severe ulcerations in stomach associated with perforation.

When amlaki (Emblica officinalis Linn.) was given to the rats through oral route in the dose of 1 g/kg/day once in a day for three consecutive days alongwith prednisolone in the dose specified as above, a decrease upto the level of 27% in the incidence of ulceration was observed. Only 10 rats out of 37 employed in this group showed the presence of ulcers in stomach. Ulcers were small mostly superficial in nature with slight haemorrhage. Adhesion was noticed in only one animal. Rest animals showed the normal appearance of the stomach. Ulcer index when calculated gave the value 6.2 . Mortality rate was 5.4%. Dead animals in course of experiment showed the evidence of perforation with severe bleeding.

Hydrocortisone induced ulcer : Effect of amlaki (Emblica officinalis Lin

Results are given in Table 6. It appears from the tabl that hydrocortisone in the dose of 50 mg/kg/day when given to the rats through intraperitonial route once in a day for consecutive three days produced massive ulcers in the animals. Ulcers, localised at the glandular portion of the stomach, were mainly penetrating in nature. In 18 rats out of 28 in this group (incidence 64.2%) frank intragastric haemorrhage was observed in ulcerated stomachs. Microscopicelly, all the

TABLE - 6 : Showing the effect of amlaki (Emblica officinalis Linn.) on hydrocortisone induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Animals with ulcers.		Animals with haemorrhage.		Other features.	Ulcer index.
			No.	%	No.	%		
CONTROL	-	25	Nil	Nil	Nil	Nil	Nil	Nil
HYDRO - CORTISONE	50 mg/kg	28(2)	28	100	18	64.2	Acute dilatation in 5, adhesion in 3.	26
HYDRO - CORTISONE + AMLAKI	50 mg/kg 1 g/kg	28(0)	8	28.5	10	35.7	Vesculer diletation in 2.	10

Brackets in parenthesis indicate the no. of animals died during experiment.

animals had erosion of mucosa, congestion in blood vessels and sometimes oedema of the mucosal and submucosal layers. 5 animals of this group showed acute dilatation while in 3 adhesion was observed. All these gave the ulcer index 26. Mortality rate was 7.14% and the dead animals showed the presence of large penetrating ulcers in their stomach.

When amlaki (Emblica officinalis Linn.) was given to the rats orally in the dose of 1 g/kg once in a day for consecutive three days in addition to hydrocortisone as stated above, only 8 rats out of 28 in this group (28.5%) showed the presence of ulcers at the glandular region of the stomach. Ulcers were mostly superficial with slight vascular dilatation and congestion of the blood vessels. 10 rats in this group (35.7%) showed haemorrhage in the stomach. Ulcer index was 10 . No animal of this group was found expired in course of experiment.

Phenylbutazone induced ulcer & Effect of amlaki (Emblica officinalis Linn.)

Table 7 shows the severity of peptic ulcers in guinea-pigs by phenylbutazone and effect of amlaki (Emblica officinalis Linn.) on such ulcers.

Guinea-pigs received phenylbutazone orally in the dose of 100 mg/kg once in a day for consecutive three days developed massive ulcers at glandular region of the stomach. Ulcers were large, mostly penetrating in nature associated with oedema of the mucosal and submucosal layers. Incidence of ulceration was 100%. 10 guinea-pigs (31.2%) showed frank haemorrhage in the ulcerated area. Gastric perforation was observed in 7 animals, acute dilatation in 5 and adhesion was in 6 guinea-pigs. All these gave the corresponding ulcer index 30.2

TABLE - 7 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on phenylbutazone induced peptic ulcers in guinea-pigs.

Group	Dose used.	No. of animals.	Animals with ulcers.		Animals with haemorrhage.		Other features.	Ulcer index.
			No.	%	No.	%		
CONTROL	-	30	Nil	Nil	Nil	Nil	Nil	Nil
PHENYL-BUTAZONE.	100 mg/kg	32(6)	32	100	10	31.2	Perforation in 7, acute dilatation in 5, adhesion in6.	30.2
PHENYL-BUTAZONE + AMLAKI	100 mg/kg 1 g/kg	30(2)	10	33.3	Nil	Nil	Ulcers were either healed or attempting to heal as shown by more fibrosis and thickening.	12.5

Brackets in parenthesis indicate the no. of animals died during experiment.

6 animals out of 32 (18.75%), expired during experiment, showed the presence of deep penetrating ulcers associated with haemorrhage and perforation.

In amlaki-fed | amlaki(Emblica officinalis Linn.) was given orally in the dose of 1 g/kg once in a day for consecutive three days alongwith phenylbutazone in the dose as stated above | group, 30 guinea-pigs were used. Only 10 guinea-pigs (33.3%) showed the presence of ulcers. Ulcers were small in size mostly superficial in nature without any haemorrhage, adhesion or vascular dilatation of the stomach. Moreover ulcers were attempting to heal as shown by more fibrosis and thickening of the stomach mucosa. All these gave the ulcer index 12.5. Mortality rate was also decreased in comparison to phenylbutazone treated group and was 6.6%.

Histamine induced ulcer : Effect of amlaki (Emblica officinalis Linn.)

Effect of amlaki (Emblica officinalis Linn.) on histamine induced peptic ulcers in mice was given in Table 8. Table shows that when histamine (33 µg/mouse) was given to mice through intraperitonial route once in a day for consecutive three days, profused ulcers were formed in the glenduler part of the stomach. 46 animals were used in this group and all animals showed the presence of ulcers. Ulcers were mostly superficial in association with adhesion (8 animals) and acute dilatation of the stomach (10 animals). Haemorrhage was observed in 86.9% of the ulcerated stomachs. Ulcer index was 25.

When amlaki (Emblica officinalis Linn.) was given to mice through oral route in the dose of 1 g/kg once in a day for consecutive three days in addition to the histamine injections as stated

TABLE - 8 : Showing the effect of amleki (Emblica officinalis Linn.) on histamine induced peptic ulcers in mice.

Group	Dose used.	No. of animals.	Animals with ulcers.		Animals with haemorrhage.		Other features.	Ulcer index.
			No.	%	No.	%		
CONTROL	-	40	Nil	Nil	Nil	Nil	Nil	Nil
HISTAMINE	33 µg/ mouse.	46(5)	46	100	40	86.9	Adhesion in 8, acute dilatation in 10.	25
HISTAMINE + AMLAKI	33 µg/ mouse. 1 g/kg	50(2)	15	30	10	36	Nil	9.6

Brackets in parenthesis indicate the no. of animals died during experiment.

above, a decrease upto the level of 30% in the incidence of peptic ulcerations was observed.Only 15 animals out of 50 in this group showed the presence of ulcers which were more precisely superficial erosions not accompanied by haemorrhage. 18 animals showed the presence of slight gastric haemorrhages but were not associated with ulcers. Stomachs of the rest animals showed microscopically the normal appearance corresponding the ulcer index value as 9.8 . In this group mortality rate was only 4% which was less in comparison to histamine treated group (10.86%).

Restraint ulcers : Effect of amlaki (Emblica officinalis Linn.)

Results are given in Table 9. It appears from the table that rats when took restraint stress developed massive ulcers in the glandular part of the stomach. Incidence of ulceration was 100%. Ulcers were large, penetrating in nature . In 92.1% of the animals frank intragastric haemorrhage was observed in ulcerated stomachs. 6 animals showed perforation, adhesion was in 7 animals while acute dilatation was observed in 5 rats. Ulcer index was 27. 5 rats out of 38 (13.15%), died during experiment, showed perforation in the stomachs.

In amlaki-fed group 35 rats were used. Amlaki (Emblica officinalis Linn.) was given orally to the rats in the dose of 1 g/kg once in a day for consecutive three days alongwith stress. Only 5 animals (14.2%) showed the presence of ulcers. Ulcers were small in size, localised at glanduler part of the stomach and were associated with frank intragastric haemorrhage. Haemorrhage was also found in another 15 rats in this group. Incidence of haemorrhage was 57.1%. Stomachs of the rest animals showed microscopically normal appearance. Ulcer index was 10.2 . Mortality rate was found 11.42%.

TABLE - 9 : Showing the effect of amlaki (Emblica officinalis Linn.) on restraint ulcers in albino rats.

Group	No. of animals.	Animals with ulcers.		Animals with haemorrhage.		Other features.	Ulcer index.
		No.	%	No.	%		
CONTROL	32	Nil	Nil	Nil	Nil	Nil	Nil
RESTRAINT	38(5)	38	100	35	92.1	Perforation in 6, acute dilatation in 5, adhesion in 7.	27
RESTRAINT + AMLAKI (Dose used, 1g/kg)	35(4)	5	14.2	20	57.1	Ulcers were attempting to heal as shown by more fibrosis and thickening.	10.2

Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 10 : Showing the effect of amlaki (Emblica officinalis Linn.) on Shay ulcers in albino rats.

Group	No. of animals.	Animals with ulcers.		Animals with haemorrhage.		Other features.	Ulcer index.
		No.	%	No.	%		
CONTROL	30	Nil	Nil	Nil	Nil	Nil	Nil
SHAY ULCER	32(4)	32	100	16	50	Adhesion in 6, acute dilatation in 4.	20
SHAY ULCER + AMLAKI (Dose used, 1g/kg)	33(4)	13	39.3	2	6	Nil	7

Brackets in parenthesis indicate the no. of animals died during experiment.

Shay ulcers : Effect of amlaki (Emblica officinalis Linn.)

Table 10 shows the severity of Shay ulcers in rats and effect of amlaki (Emblica officinalis Linn.) on such ulcers. It appears from the Table that by Shay technique severe ulcers were formed in the stomach. Incidence of ulceration was 100%. Ulcers were at the glandular part of the stomach, penetrating in nature associated with oedema of the mucosal and submucosal layers. 16 out of 32 rats in this group (50%) showed frank haemorrhage in the stomach. Acute dilatation of the blood vessels was found in 6 rats, while adhesion was observed in 4 animals. Calculated ulcer index was 20. 4 rats out of 32 (12.5%), died during experiment, showed severe bleeding in the stomach.

When amlaki (Emblica officinalis Linn.) was given to the rats orally in the dose 1 g/kg once in a day for consecutive three days alongwith Shay stress, incidence of ulceration was going down to 39.3%. Ulcers formed were small, mostly superficial in nature and were attempting to heal as shown by more fibrosis and thickening of the mucosa. Only 2 rats out of 33 in this group (6%) showed haemorrhage in the stomach. Stomachs of the rest animals gave normal appearence under microscope. Ulcer index was going down to 7. Mortality rate was 12.12%.

Control animals in all the groups did not show the presence of ulcers in the stomachs.

Chapter - II

STUDIES ON ACID - PEPTIC FACTOR IN EXPERIMENTAL ULCERS : ROLE OF AMLAKI (*Emblica officinalis* Linn.)

C H A P T E R - II

To study the effect of amlaki (Emblica officinalis Linn.) on the rate of gastric secretion, gastric acidity and peptic activity during experimental ulcerations, collected gastric juice samples (page, 19) were analysed by the following methodologies. Nature of ulcerogenic drugs/methods, type of animals, doses of drug and amlaki (Emblica officinalis Linn.) , route of administration, duration of anaesthesia and operative technique were essentially same as described in Chapter - I.

Materials

For acidity estimation :

a. 0.02 (N) equeous solution of sodium hydroxide was prepared fresh at the time of estimation.

b. Topfer's reagent : 0.5% alcoholic solution of dimethyl amino azo benzene (Riedel-DeHae-nag-seelze-Hannover-Germany) was prepared and

stored in glass stoppered bottle.

c. 1% alcoholic solution of phenolpthalein (Merck,USA) was made and kept in a glass stoppered bottle.

For peptic activity estimation :

a. 0.01 (N) and 0.06 (N) aqueous solutions of hydrochloric acid were prepared from concentrated hydrochloric acid (Analar, BDH) with distilled water and kept in glass stoppered bottles seperately.

b. Haemoglobin solution (E.Merck) : 2% haemoglobin solution in 0.06 (N) hydrochloric acid was prepared fresh before use.

c. Trichloroacetic acid (Reanal, Budapest) : 10% solution was made by dissolving 100g trichloroacetic acid in 1 litre of distilled water and kept in glass stoppered bottle.

d. Phenol reagent (Folin & Ciocalteu's reagent) :

Sodium tungstate (Analar, BDH)	100g
Sodium molybdate (Analar, BDH)	25g
Phosphoric acid, 85-90% (BDH)	50 ml
Concentrated hydrochloric acid (Analar, BDH)	100 ml
Lithium sulphate (BDH)	150g
Bromine (E. Merck)	Few drops.

Sodium tungstate and sodium molybdate were dissolved in 700 ml of distilled water in a 2 litre round bottom flask and to this were added phosphoric and hydrochloric acids and then refluxed for 10 hours. Next lithium sulphate alongwith 50 ml of water and few drops of bromine were added. It was then boiled for 15 minutes without condenser to remove excess of bromine. The mixture was then cooled and distilled water was added to make up the volume to 100 ml and filtered. The stock solution was kept in refrigerator.

e. Alkaline reagent : 2g of sodium carbonate (Analar,BDH) was added to 100 ml of 0.1 (N) aqueous solution of sodium hydroxide (Analar,BDH).

f. Alkaline mixture : To 100 ml of alkaline reagent 1 ml of 4% aqueous potassium tartarate (E. Merck) and 1 ml of 2% aqueous copper sulphate (Analar,BDH) were added. This was prepared fresh before use.

Methodologies

Determination of volume : Volumes of gastric juice samples were individually measured with the help of a 5 ml graduated pipette and expressed in terms of ml/100g body weight of the animal/4h secretion.

Determination of acidity : 0.2ml of centrifuged blood free gastric juice sample was taken in a porcelein evaporating dish. It was diluted with 2 ml of distilled water. To it was added a drop of Topfer's reagent when a pink colour developed. It was then titrated with 0.02 (N) sodium hydroxide until a salmon pink colour (a point in between pink and yellow) was observed. To it was next added a drop of 1% alcoholic solution of phenolpthalin and the titration was continued till it turned pink.The burette reading at this point was a measure of acidity. Acidity was expressed in terms of mEq/dl and the output was calculated by multiplying each value with the respective volume of gastric juice as expressed in terms of ml/100g/4h. The aforesaid procedure to determine the gastric acidity was essentially the same as described by Verley[131].

Determination of peptic activity : Peptic activity of gastric juice was estimated employing a modified method of Anson[132]. 1 ml of 1:250 (diluted with0.01(N) hydrochloric acid) gastric juice was added to 2.5 ml of 2% haemoglobin solution in 0.06 (N) hydrochloric acid. The mixture was

incubated at 37°C for 20 minutes. Immediately thereafter an equal volume of ice cold 0.6 M trichloro acetic acid was added. The mixture tubes were then kept in ice bath for another 15 minutes and after this period the samples were centrifuged to seperate the precipiteted proteins. 1 ml of clear supernatant was used to determint the concentration of liberated amino acids following the method of Lowry et al.[133] The optical densities were measured with 'spectronic 20' absorptiometer set at 610nm against a blank similarly prepared using 0.01 (N) hydrochloric acid instead of diluted gastric juice. The peptic activity was expressed in terms of µmol tyr/ml and output was calculated by multiplying each value with the respective volume of gastric juice as expressed in terms of ml/100g/4h.

Student's 't' test was applied to evaluate the data.

Results

Results are given in and from Table 11 to Table 20.

Aspirin induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric secretion, gastric acidity and peptic activity.

Table 11 shows the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in aspirin induced ulcers in albino rats. It appears from the table that no significant changes in gastric juice volume, gastric acidity and peptic activity were observed in the animals received aspirin (100 mg/kg, once in a day for consecutive three days intraperitonially) when compared to that of control animals.

In amlaki-fed group | amlaki (Emblica officinalis Linn

TABLE - 11 : Showing the effect of amlaki (Emblica officinalis Lin.) on rate of gastric secretion, gastric acidity and peptic activity in aspirin induced ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
					mEq/ml	Output	µmol tyr. /ml	Output
CONTROL	-	25	Nil	2.69 ± 0.6	90 ±9.1	242.1 ±19.7	330 ±33.8	887.7 ±58.9
ASPIRIN	100 mg/kg	30 (5)	23.1	2.6 ±0.58	90 ±10.1	234 ±20	320 ±33.8	832 ±60
ASPIRIN + AMLAKI	100 mg/kg 1 g/kg	32 (2)	11.2	2.52 ±0.52	87 ±6	219.2 ±25	321 ±38	808.9 ±60

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

was given to the rats in the dose of 1 g/kg once in a day for consecutive three days alongwith aspirin | a low trend in the rate of gastric secretion, output in gastric acidity and peptic activity was observed when compared to that of aspirin treated group but results were not statistically significant.

Salicylic acid induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric secretion, gastric acidity and peptic activity.

Results are given in Table 12.Salicylic acid, when given to albino rats in the dose of 100 mg/kg/day once in a day for consecutive three days, did not exert any significant effect in rate of gastric secretion, gastric acidity and peptic activity when compared to that of the control animals. Amlaki (Emblica officinalis Linn. treatment in the dose of 1 g/kg/day given orally once in a day for consecutive three days alongwith salicylic acid did not also bring about any significant changes in rate of gastric secretion, output of gastric acidity anf peptic activity when compared to that of salicylic acid treated group.

Paracetamol induced ulcer : Effect of amlaki (Emblica officinalis Linn. on gastric secretion, gastric acidity and peptic activity.

Table 13 shows the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in paracetamol induced peptic ulcers in albino rats. It appears from the table that paracetamol in the dose of 100 mg/kg when given to the rats intraperitonially once in a day for consecutive three days caused no significant changes in rate of gastric secretion,

TABLE - 12 : Showing the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in salicylic acid induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
					mEq/ml	Output	µmol tyr./ml	Output
CONTROL	-	30	Nil	2.6 ±0.57	85 ±9	221 ±20	320 ±32	832 ±60.2
SALICYLIC ACID	100 mg/kg	32 (6)	24	2.52 ±0.58	89 ±9.1	224.2 ±21.2	330 ±30	831.6 ±59.8
SALICYLIC ACID + AMLAKI	100 mg/kg 1 g/kg	30 (3)	13.4	2.58 ±0.62	87 ±8.9	224.4 ±20.8	318 ±33.3	820.4 ±62.2

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 13 : Showing the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in paracetamol induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
					mEq/ml	Output	µmol tyr./ ml	Output
CONTROL	-	29	Nil	2.72 ±0.7	72 ±10	195.8 ±20.2	300 ±33	816 ±72.2
PARACETAMOL	100 mg/kg	35 (6)	25	2.6 ±0.6	69.9 ±9.2	181.7 ±21.5	340 ±38	884 ±80
PARACETAMOL + AMLAKI	100 mg/kg 1 g/kg	33 (2)	8.3	2.58 ±0.61	72 ±10.1	185.7 ±20.1	322.5 ±37.2	832 ±79.5

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

gastric acidity and peptic activity when compared to that of control animals although a low trend in rate of gastric secretion, output of acidity and a high trend in the output of peptic activity were observed.

When emlaki (Emblica officinalis Linn.) was given to the rats orally (dose was 1 g/kg once in a day for consecutive three days) alongwith the aforesaid dose of paracetamol, slight changes in the rate of gastric secretion, gastric acidity and peptic activity took place but the results were not statistically significant when compared to that of paracetamol treated group.

Indomethacin induced ulcer : Effect of amlaki (Emblica officinalis Linn. on gastric secretion, gastric acidity and peptic activity.

Effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in indomethacin induced peptic ulcers in albino rats was given in Table 14. Indomethacin, when given to the rats through intraperitoneal injection (dose, 25 mg/kg once in a day for consecutive three days) did not exert any significant changes in gastric juice volume, gastric acidity and peptic activity when compared to that of control animals.Amlaki (Emblica officinalis Linn.) treatment in the dose of 1 g/kg/day given orally to the rats once in a day for consecutive three days in addition to indomethacin treatment did not also exert any significant changes in rate of gastric secretion, gastric acidity and peptic activity when compared to that of indomethacin treated group. A low trend in the rate of gastric secretion, gastric acidity was observed in this group but the results were not statistically significant.

TABLE - 14 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on rate of gastric secretion, gastric acidity and peptic activity in indomethacin induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
					mEq/ml	Output	µmol tyr./ ml	Output
CONTROL	-	26	Nil	2.8 ±0.8	84 ±9.8	235.2 ±25	300 ±30.8	840 ±82.5
INDOMETHACIN	25 mg/kg	28 (2)	27.5	2.82 ±0.85	90 ±10	253.8 ±26.2	310 ±31	874.2 ±80
INDOMETHACIN + AMLAKI	25 mg/kg 1 g/kg	25 (1)	11	2.75 ±0.79	88 ±8.6	242 ±24.8	318 ±30.6	874.5 ±79.8

Results are mean ± S.E.

Brackets in perenthesis indicate the no. of animals died during experiment.

Prednisolone induced ulcer : Effect of amlaki(Emblica officinalis Linn. on gastric secretion, gastric acidity and peptic activity.

Results are given in Table 15. It reveals from the table that prednisolone, when given intraperitonially to albino rats in the dose of 30 mg/kg once in a day for consecutive three days, had no effect on the rate of gastric secretion, gastric acidity and peptic activity of ulcerated stomach. Values for gastric juice volume and gastric acidity showed a decreased trend while peptic activity value an increased trend when compared with control values but the values were statistically not significant.

Oral administration of amlaki (Emblica officinalis Linn.) to the rats in the dose of 1 g/kg once in a day for consecutive three days alongwith prednisolone in the dose as stated above did not also exert any significant change in rate of gastric secretion, gastric acidity and peptic activity when compared to that of prednisolone treated group.

Hydrocortisone induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric secretion, gastric acidity and peptic activity.

Results are given in Table 16. Intraperitoneal injections of hydrocortisone (50 mg/kg/day, once in a day for three consecutive days)to albino rats did not exert any significant effect on rate of gastric secretion, gastric acidity and peptic activity when compared to that of the control animals. Amlaki (Emblica officinalis Linn.) treatment in the dose of 1 g/kg given orally to the rats once in a day for consecutive three days alongwith hydrocortisone did not also

TABLE - 15 : Showing the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in prednisolone induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
					mEq/ml	Output	/umol tyr./ ml	Output
CONTROL	-	30	Nil	2.6 ±0.52	90 ±10	234 ±26	318 ±31.8	826.8 ±80.8
PREDNISOLONE	30 mg/kg	33 (4)	22.4	2.55 ±0.49	84 ±9.2	214.2 ±25.2	340 ±40	867 ±79.9
PREDNISOLONE + AMLAKI	30 mg/kg 1 g/kg	37 (2)	8.2	2.62 ±0.5	87 ±9.8	227.9 ±26.2	330 ±39.3	864.6 ±82.8

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE-16 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on rate of gastric secretion, gastric acidity and peptic activity in hydrocortisone induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
					mEq/ml	Output	µmol tyr./ml	Output
CONTROL	-	25	Nil	2.7 ±0.6	80 ±9.2	216 ±20.8	300 ±30.2	810 ±69.2
HYDROCORTISONE	50 mg/kg	28 (2)	26	2.52 ±0.58	89 ±10.4	224.2 ±20.9	320 ±31.9	806.4 ±75.5
HYDROCORTISONE + AMLAKI	50 mg/kg 1 g/kg	28 (0)	10	2.5 ±0.61	85 ±9.2	212.5 ±22.2	312 ±30.9	780 ±75.8

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

exert any significant change in the rate of gastric secretion, gastric acidity and peptic activity when compared to that of hydrocortisone treated group.

Phenylbutazone induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric secretion, gastric acidity and peptic activity.

Table 17 shows the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in phenylbutazone induced peptic ulcers in guinea-pigs. In comparison to control data an increase trend in gastric secretion, output of gastric acidity and peptic activity was observed in phenylbutazone induced ulceration (phenylbutazone in the dose of 100 mg/kg, given to guinea-pigs orally once in a day for three consecutive days) but the increase was not statistically significant.

When amlaki (Emblica officinalis Linn.) was given to the guinea-pigs orally in the dose of 1 g/kg once in a day for consecutive three days in addition to phenylbutazone, no significant change in the level of gastric secretion, gastric acidity and peptic activity was observed when compared to that of phenyl butazone group only.

Histamine induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric secretion, gastric acidity and peptic activity.

Results are given in Table 18. It appears from the table that histamine in the dose of 33 µg/mouse/day when given to the mice intraperitonially once in a day for three consecutive days produced massive ulcers in the stomach but did not exert any significant changes

TABLE-17 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on rate of gastric secretion, gastric acidity and peptic activity in phenylbutazone induced peptic ulcers in guinea-pigs.

Group	Dose used.	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
					mEq/ml	Output	µmol tyr. /ml	Output
CONTROL	-	30	Nil	3.6 ±0.8	92 ±10	331.2 ±30.2	357 ±35.2	1285.2 ±80.5
PHENYLBUTAZONE	100 mg/kg	32 (6)	30.2	3.75 ±0.82	90 ±9.2	337.5 ±31	362 ±35	1357.5 ±90
PHENYLBUTAZONE + AMLAKI	100 mg/kg 1 g/kg	30 (2)	12.5	3.7 ±0.81	87 ±9	321.5 ±30.8	350 ±33	1299 ±92.2

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE-18 : Showing the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in histamine induced peptic ulcers in mice.

Group	Dose used.	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
					mEq/ml	Output	µmol tyr./ ml	Output
CONTROL	-	40	Nil	1.0 ±0.1	75 ±8	75 ±8.2	287 ±30	287 ±31.1
HISTAMINE	33 µg/ mouse.	46 (5)	25	0.95 ±0.09	72 ±7	68.4 ±7.4	298 ±29.2	283.1 ±30
HISTAMINE + AMLAKI	33 µg/ mouse 1 g/kg	50 (2)	9.8	0.97 ±0.08	73 ±8.2	70.8 ±8.3	290 ±30.2	281.3 ±28.9

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

in rate of gastric secretion, gastric acidity and peptic activity in comparison to control data. Amlaki (Emblica officinalis Linn.) when given to the mice orally in the dose of 1 g/kg once in a day for a consecutive three days alongwith histamine did not also exert any significant effect on volume of gastric secretion, output of gastric acidity and peptic activity when compared to that of histamine group.

Restraint ulcer : Effect of amleki (Emblica officinalis Linn.) on gastric secretion, gastric acidity and peptic activity.

Table 19, relating to the effect of amleki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in restraint ulcers in albino rats, shows that restraint stress produced ulcers but it was not associated with any significant changes in the levels of rate of gastric secretion, gastric acidity and peptic activity in comparison to control value.These parameters again showed no significant changes when amlaki (Emblica officinalis Linn.) was given to the rats orally in the dose of 1 g/kg once in a day for consecutive three days alongwith stress when compared the data obtained for restraint group only.

Shay ulcers : Effect of amlaki (Emblica officinalis Linn.) on gastric secretion, gastric acidity and peptic activity.

Results are given in Table 20. It appears from the table that Shay technique for the production of gastric ulcers in albino rats did not exert any significant effect on rate of gastric secretion, gastric acidity and peptic activity when compared to the control data. Amlaki (Emblica officinalis Linn.) treatment to the

TABLE-19 : Showing the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in restraint ulcers in albino rats.

Group	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
				mEq/ml	Output	/umol tyr. /ml	Output
CONTROL	32	Nil	2.8 ±0.8	85 ±9	236 ±22	290 ±30	812 ±79
RESTRAINT	38 (5)	27	2.62 ±0.72	80 ±8.2	209.6 ±21.2	300 ±32.1	786 ±80.2
RESTRAINT + AMLAKI (Dose used, 1g/kg)	35 (4)	10.2	2.67 ±0.7	82 ±9	218.9 ±20	310.5 ±31.9	829 ±81.5

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 20 : Showing the effect of amlaki (Emblica officinalis Linn.) on rate of gastric secretion, gastric acidity and peptic activity in Shay ulcers in albino rats.

Group	No. of animals.	Ulcer index.	Volume ml/100g (4h)	Acidity		Peptic activity	
				mEq/ml	Output	µmol tyr. /ml	Output
CONTROL	30	Nil	3.0 ±0.32	75 ±8	225 ±20.2	311 ±30	933 ±90
SHAY ULCER	32 (4)	20	2.8 ±0.3	82 ±8.2	229.6 ±21.2	320.5 ±29.8	897.4 ±90.9
SHAY ULCER + AMLAKI (Dose used, 1g/kg)	33 (4)	7	2.9 ±0.32	80 ±9	232 ±23	308 ±30.2	893.2 ±87.5

Results are mean ± S.E.

Brackets in parenthesis indicate the no. of animals died during experiment.

rats in the dose of 1 g/kg orally once in a day for three consecutive days alongwith Shay stress did not also exert any significant changes in the volume of gastric secretion, gastric acidity and peptic activity when compared to that of 'Shay ulcer' group.

Chapter - III

STUDIES ON DISSOLVED GASTRIC MUCIN IN EXPERIMENTAL ULCERS : ROLE OF AMLAKI (*Emblica officinalis* Linn.)

C H A P T E R - III

To study the effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin during experimental ulcerations, collected gastric juice samples (page, 19) were analysed by the following methodologies. Nature of ulcerogenic drugs/methods, type of animals, doses of drugs and amlaki (Emblica officinalis Linn.), route of administration, duration of anaesthesia and operative technique were essentially same as described in Chapter - I .

Materials

For analysis of dissolved gastric mucin :

a. Ethyl alcohol : 95% ethyl alcohol (Bengal Chemical) was used.

b. 0.1(N) aqueous sodium hydroxide was prepared fresh at the time of analysis.

c. 0.1(N) sulphuric acid was prepared fresh at the time of analysis by

diluting concentrated sulphuric acid stepwise with distilled water.

d. 6(N) hydrochloric acid was prepared from concentrated hydrochloric acid (BDH, Analar) and kept in glass stoppered bottle.

For total hexose estimation :

a. Orcinol (E.Merck) : 1.6% in a solution of distilled water was prepared and stored in refrigerator.

b. Sulphuric acid : Water mixture : This was prepared by adding 3 volumes of concentrated sulphuric acid (Analar, BDH) to 2 volumes of distilled water slowly with constant stirring. It was kept in a glass stoppered bottle and stored in refrigerator.

c. Orcinol : Sulphuric acid mixture : This was made by adding one volume of 1.6% orcinol solution to 7.5 volumes of sulphuric acid - water mixture (3:2 , V/V) only at the time of estimation.

d. Galactose, Mannose (BDH) : These were used as standards for total hexose estimation.

For hexosamine estimation :

a. Hydrochloric acid : 0.2(N) and 6(N) solutions were prepared from concentrated hydrochloric acid (Analar, BDH) by diluting with distilled water and stored in glass stoppered bottles seperately.

b. Sodium hydroxide (E.Merck) : 4(N) solution was prepared by dissolving pellets in distilled water and stored in a glass bottle.

c. Phenolpthalein (E. Merck) : 1% alcoholic solution was prepared and stored in glass stoppered bottle.

d. Acetyl acetone reagent : 0.3 ml acetyl acetone (E. Merck) and 9.7 ml of 1.5(N) sodium carbonate (Analar, BDH) were mixed just before use.

e. Ethanol (Bengal Chemical) was dehydrated with lime and distilled before use.

f. Ehrlich's reagent : This reagent was made by dissolving 1.6 g of p-dimethylamino-benzaldehyde (E.Merck) in 30 ml of 95% ethanol and then was added 30ml of concentrated hydrochloric acid. This reagent was kept in refrigerator.

g. D(+) Glucosamine hydrochloride (BDH) was used as standard in hexosamine estimation.

For methyl pentose estimation :

a. Ethanol was dehydrated with lime and distilled before use.

b. Sulphuric acid-Water mixture : 6 volumes of concentrated sulphuric acid (Analar, BDH) was added to 1 volume of distilled water slowly with constant stirring. It was kept in a glass stoppered bottle and stored in refrigerator.

c. Cysteine reagent : 600 mg cysteine hydrochloride (E.Merck) was dissolved in 20 ml of distilled water. It was prepared weekly, stored in refrigerator.

d. Methyl pentose standard : 5 mg of methyl pentose (Sigma) was dissolved in 50 ml of distilled water in a volumetric flask. 1 ml of this solution was diluted to 2.5 ml of distilled water to make it suitable for standard concentration. It was stored in refrigerator.

For sialic acid estimation :

a. Sodium periodate, meta (BDH) : 0.2 M in 9 M orthophosphoric acid (BDH) solution was prepared and stored in glass stoppered bottle. This was prepared every 20 days.

b. Sodium arsenite (E. MERCK) : 10% in a solution of 0.5 M sodium sulphate (Analar, BDH) was prepared in 0.1(N) sulphuric acid (Analar, BDH) and stored in glass stoppered bottle. This was prepared every 20 days.

c. Thiobarbituric acid : 0.6% of thiobarbituric acid (E.Merck) in a solution of 0.5 M sodium sulphate (Analar, BDH) was prepared and filtered. It was kept in glass stoppered bottle. This was prepared every 20 days.

d. Cyclohexanone (Reanal, Budapest) : Original solution was used.

Methodologies

Analysis of dissolved gastric mucin : Dissolved gastric mucin was analysed according to our earlier published report[134]. To 0.5 ml of clear gastric juice, 5 ml of 95% ethyl alcohol was added. After 10 mins. it was centrifuged at 5000 r.p.m. for a period of 10 minutes and then the supernatant was drained out. The precipitate was allowed to dry in the tube for next 10 minutes. The precipitate was dissolved in 0.5 ml of 0.1(N) sodium hydroxide. 0.2 ml of this solution was then hydrolysed with 0.6 ml of 0.1(N) sulphuric acid at 100°C for 1 hour to liberate sialic acids from dissolved mucin. Remaining 0.3 ml of the solution was hydrolysed with 0.9 ml of 6(N) hydrochloric acid at 100°C for 2 hours to liberate neutral and amino sugars. The hydrolysates were then neutralised by 0.1 (N) sodium hydroxide and the volume was made upto 2 ml for first aliquot and 3 ml for the second aliquot.

Released sialic acid in the first aliquot was estimated by thiobarbituric acid method of Warren[135]. From the second

aliquot hexosamine was measured by the method of Dische and Borenfreund[136] and total hexose, methyl pentose were estimated by the method of Dische and Shettles[137]. The sum of total hexose, hexosamine, methyl pentose and sialic acid i.e. total carbohydrate was taken as the index of the level of dissolved gastric mucin as suggested by Menguy[5], was expressed in terms of mg/mg of dissolved mucin.

Estimation of total hexose : Total hexose of dissolved gastric mucin was estimated by the method of Dische and Shettles[137] according to the following protocol :

	Blank	Standard	Unknown
Water	1 ml	Nil	Nil
Galactose-mannose solution, 1:1. (0.1mg/ml)	Nil	1 ml	Nil
Orcinol-Sulphuric acid mixture. (1 : 7.5)	4.25 ml	4.25 ml	4.25 ml
Sample(Neutralised second aliquot, page 46)	Nil	Nil	1 ml

Contents of the tubes were then heated in a boiling water bath for exactly 15 minutes, cooled and the intensities of the developed colour were recorded at 540nm using 'Spectronic 20' against the blank. The amount of total hexose in unknown sample was calculated on the basis of standard concentration and was expressed in terms of mg / mg of dissolved mucin.

Estimation of hexosamine : Hexosamine of dissolved gastric mucin was estimated by the method of Dische and Borenfreund[136] according to the following protocol.

	Blank	Standard	Unknown
Water	1 ml	Nil	Nil
Standard glucosamine solution. (0.05 mg/ml)	Nil	1 ml	Nil
Sample (Neutralised second aliquot, page, 46)	Nil	Nil	1 ml
Acetyl acetone reagent	1 ml	1 ml	1 ml

Contents of the tubes were heated for 20 minutes in a boiling water bath and then cooled. Then

Ethyl alcohol	3 ml	3 ml	3 ml
Ehrlich's reagent	1 ml	1 ml	1 ml

Tubes were then kept at room temperature for 30 minutes and the intensities of the developed colour were recorded at 530 nm using 'Spectronic 20' against the blank. The amount of hexosamine in unknown sample was calculated on the basis of standard concentration and was expressed in terms of mg / mg of dissolved mucin.

Estimation of methyl pentose : Methyl pentose of dissolved gastric mucin was estimated by the method of Dische and Shetteles[137] according to the following protocol :

	Blank	Standard	Unknown
Water	1 ml	Nil	Nil
Methyl pentose solution. (0.02 mg/ml)	Nil	1 ml	Nil
Sample (Neutralised second aliquot, Page 46)	Nil	Nil	1 ml

(Protocol - Contd.)

	Blank	Standard	Unknown
Sulphuric acid -water mixture.	4.5 ml	4.5 ml	4.5 ml

Contents of the tubes were heated in a boiling water bath for exactly 3 minutes then cooled then

Cysteine reagent.	0.1 ml	0.1 ml	0.1 ml

Contents of the tubes were mixed thoroughly and kept at room temperature for 1 hour. After 1 hour intensities of the developed colour were recorded at 396 nm and at 430 nm using spectrophotometer setting the instrument with blank. One more unknown tube was prepared exactly in the same way described above without adding cysteine reagent. This was as a correction for any non-specific colour as suggested by Dische and Shettles[137]. The amount of methyl pentose in unknown sample was calculated from the difference in reading obtained at 396 nm and 430 nm and substracting the values without cysteine as under :

$$\text{Concentration of methyl pentose in unknown sample} = \frac{(A - A') - (B - B')}{(C - C')} \times \text{Strength of the standard solution} \times \text{Dilution factor.}$$

where,

A = Optical density of unknown sample at 396 nm with cysteine

A' = Optical density of unknown sample at 430 nm with cysteine.

B = Optical density of unknown sample at 396 nm without cysteine.

B' = Optical density of unknown sample at 430 nm without cysteine.

C = Optical density of standard solution at 396 nm.

C' = Optical density of standard solution at 430 nm.

The amount of methyl pentose in unknown sample was expressed in terms of mg / mg of dissolved mucin.

Estimation of sialic acid : Sialic acid of dissolved gastric mucin was estimated by the method of Warren[135] according to the following protocol :

	Blank	Standard	Unknown
Water	1 ml	Nil	Nil
Sialic acid solution (0.05 mg/ml)	Nil	1 ml	Nil
Sample (Neutralised, first aliquot, Page 46)	Nil	Nil	1 ml
Sodium periodate solution.	0.1 ml	0.1 ml	0.1 ml

Contents of the tubes were mixed up properly and kept for 20 minutes at room temperature, then

Sodium arsenite solution.	1 ml	1 ml	1 ml
Thiobarbituric acid solution.	3 ml	3 ml	3 ml

Contents of the tubes were then heated in a boiling water bath for exactly 15 minutes, cooled. then,

Cyclohexanone	4.3 ml	4.3 ml	4.3 ml

Contents of the tubes were again mixed well and centrifuged. Cyclohexanone layer was carefully taken out

and its colour intensity was recorded at 532 nm and at 550 nm using 'Spectronic 20' against the blank. The amount of sialic acid in unknown sample was calculated from the difference in reading obtained at 532 nm and 550 nm on the basis of standard concentration and expressed in terms of mg / mg of dissolved mucin.

Student's 't' test was applied to evaluate the data.

Results

Results are given in and from Table 21 to Table 30.

Aspirin induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin.

Table 21 shows the effect of amlaki (Emblica officinalis Linn.) on various carbohydrate components of dissolved gastric mucin in aspirin induced peptic ulcers in albino rats.

Aspirin in the dose of 100 mg/kg/day, when given to rats intraperitonially once in a day for consecutive three days, caused a significant decrease ($p \leq 0.01$, $p \geq 0.001$) in the levels of hexosamine, methyl pentose, sialic acid and thus in total carbohydrate when compared to that of control animals. No significant decrease, however, was observed in total hexose level.

Amlaki fed rats | amlaki (Emblica officinalis Linn.) was given in the dose of 1 g/kg/day orally once in a day for three consecutive days alongwith aspirin |, on the contrary, showed a significant increase ($p \geq 0.01 - \geq 0.001$) in the levels of hexosamine, methyl pentose and sialic acid thus total carbohydrates when compared to that of aspirin treated group. No significant increase was also observed in total hexose concentration.

TABLE - 21 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on the carbohydrate components of dissolved gastric mucin in aspirin induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	25	Nil	0.10 ±.009	0.05 ±0.004	0.03 ±.003	0.08 ±.008	0.26 ±.015
ASPIRIN	100 mg/kg	30 (5)	23.1	0.08 ±.007	0.02*** ±.001	0.01*** ±.001	0.05*** ±.005	0.16*** ±0.01
ASPIRIN + AMLAKI	100 mg/kg 1 g/kg	32 (2)	11.2	0.10 ±.01	0.035*** ±.002	0.03*** ±.002	0.08** ±.01	0.245*** ±0.02

Results are mean ± S.E. ; * : Sign of significance, ** : $p < 0.01$, *** : $p < 0.001$.
Brackets in parenthesis indicate the no. of animals died during experiment.

Salicylic acid induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin.

Results are given in Table 22. It appears from the table that when salicylic acid in the dose of 100 mg/kg/day was given to the rats intraperitonially once in a day for consecutive three days , significant decrease was found in the level of hexosamine ($p < .001$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of dissolved gastric mucin when compared to those values of control animals. Total hexose of dissolved gastric mucin, however, did not show any significant change.

When amlaki (Emblica officinalis Linn.) was given to the rats through oral route in the dose of 1 g/kg/day once in a day for consecutive three days alongwith salicylic acid, significant increase in the levels of hexosamine ($p < .01$), methyl pentose ($p < .001$) sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of dissolved gastric mucin was observed when compared to those values in aspirin treated group. No significant increase was found in total hexose concentration.

Paracetamol induced ulcer : Effect of amlaki (Emblica officinalis Linn. on dissolved gastric mucin.

Effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in paracetamol induced peptic ulcers in albino rats, was given in Table 23.

Paracetamol in the dose of 100 mg/kg, when given to rats intraperitonially once in a day for consecutive three days, caused

TABLE - 22 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in salicylic acid induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	30	Nil	0.11 ±.009	0.05 ±.005	0.04 ±.004	0.07 ±.007	0.27 ±.015
SALICYLIC ACID	100 mg/kg	32 (6)	24	0.09 ±.008	0.025*** ±.001	0.012*** ±.001	0.04*** ±.003	0.167*** ±.009
SALICYLIC ACID + AMLAKI	100 mg/kg 1 g/kg	30 (3)	13.4	0.108 ±.012	0.04** ±.005	0.028*** ±.001	0.075*** ±.006	0.25*** ±.018

Results are mean ± S.E. ; * : Sign of significance, ** : $p < 0.01$, *** : $p < 0.001$.
Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 23 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in paracetamol induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate (mg/mg of mucin)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	29	Nil	0.10 ±.006	0.06 ±.005	0.038 ±.002	0.078 ±.006	0.276 ±.02
PARACETAMOL	100 mg/kg	35 (6)	25	0.089 ±.004	0.038*** ±.002	0.011*** ±.001	0.032*** ±.001	0.17*** ±.01
PARACETAMOL + AMLAKI	100 mg/kg 1 g/kg	33 (2)	8.3	0.101 ±.009	0.057*** ±.004	0.032** ±.002	0.091*** ±.006	0.281*** ±.02

Results are mean ± S.E.; * : Sign of significance, ** : p /0.01, *** : p /0.001, Brackets in parenthesis indicate the no. of animals died during experiment.

a significant decrease ($p < .001$) in the levels of hexosamine, methyl pentose, sialic acid and thus in total carbohydrate of dissolved gastric mucin when compared to those values of control animals. Total hexoses of dissolved gastric mucin did not show any significant change by paracetamol.

In addition to paracetamol as stated above when amlaki (Emblica officinalis Linn.) was given to the rats in the dose of 1 g/kg once in a day for consecutive three days through oral route, significant increase in the levels of hexosamine ($p < .001$), methyl pentose ($p < .01$), sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of dissolved gastric mucin was observed when compared to those values in paracetamol treated group. Total hexose part of dissolved gastric mucin in this case did not also show any significant change in comparison to that of paracetamol treated group.

Indomethacin induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin .

Results are given in Table 24. Indomethacin in the dose of 25 mg/kg when given to the rats intreperitonially once in a day for consecutive three days caused significant decrease ($p < .001$) in the levels of hexosamine, methyl pentose, sialic acid and thus in total carbohydrate of dissolved gastric mucin when compared to those values of control animals. Total hexose part of dissolved gastric mucin, however, did not show any change.

Amlaki-fed rats | amlaki (Emblica officinalis Linn.) was given to the rats orally in the dose of 1 g/kg once in a day for consecutive three days alongwith indomethacin | , on the contrary , showed significant increase in the levels of hexosamine ($p < .001$),

TABLE - 24 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in indomethacin induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	26	Nil	0.12 ±.02	0.07 ±.006	0.04 ±.002	0.08 ±.009	0.31 ±.02
INDOMETHACIN	25 mg/kg	28(2)	27.5	0.10 ±.01	0.04*** ±.002	0.01*** ±.001	0.04*** ±.004	0.19*** ±.012
INDOMETHACIN + AMLAKI	25 mg/kg 1 g/kg	25(1)	11.0	0.12 ±.01	0.08*** ±.007	0.03** ±.002	0.07** ±.009	0.30*** ±.026

Results are mean ± S.E.; * : Sign of significance, ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the no. of animals died during experiment.

methyl pentose ($p < .01$), sialic acid ($p < .01$) and thus in total carbohydrate ($p < .001$) of dissolved gastric mucin when compared to that of indomethacin treated group. No significant increase was observed in total hexose concentration.

Prednisolone induced ulcer : Effect of amlaki (Emblica officinalis Linn on dissolved gastric mucin .

Effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in prednisolone induced peptic ulcers in albino rats was given in Table 25.

Prednisolone in the dose of 30 mg/kg, when given to the rats intraperitonially once in a day for consecutive three days, caused a significant decrease in the levels of total hexose ($p < .001$), hexosamine ($p < .001$), methyl pentose ($p < .01$), sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of dissolved gastric mucin when compared to those values of control animals.

When amlaki (Emblica officinalis Linn.) was given to the rats orally in the dose of 1 g/kg/day once in a day for consecutive three days in addition to prednisolone, significant increase in the levels of total hexose ($p < .001$), hexosamine ($p < .001$), methyl pentose ($p < .01$), sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of dissolved gastric mucin was observed when compared to those of prednisolone treated group.

Hydrocortisone induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin .

Results are given in Table 26. It appears from the

TABLE - 25 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in prednisolone induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	30	Nil	0.12 ±.009	0.06 ±.004	0.032 ±.002	0.078 ±.006	0.29 ±.018
PREDNISOLONE	30 mg/kg	33(4)	22.4	0.07*** ±.004	0.04*** ±.002	0.01** ±.001	0.03*** ±.002	0.15*** ±.009
PREDNISOLONE + AMLAKI	30 mg/kg 1 g/kg	37(2)	8.2	0.10*** ±.008	0.06*** ±.004	0.03** ±.002	0.08*** ±.006	0.27*** ±.01

Results are mean ± S.E., * : Sign of significance; ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 26 : Showing the effect of amleki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in hydrocortisone induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin)
				Total hexoses.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	25	Nil	0.11 ±.001	0.065 ±.005	0.04 ±.003	0.08 ±.007	0.295 ±.02
HYDROCORTISONE	50 mg/kg	28(2)	26	*** 0.06 ±.005	** 0.042 ±.005	*** 0.012 ±.001	*** 0.04 ±.003	*** 0.154 ±.01
HYDROCORTISONE + AMLAKI	50 mg/kg 1 g/kg.	28(0)	10	*** 0.12 ±.009	** 0.07 ±.006	*** 0.038 ±.002	*** 0.072 ±.006	*** 0.30 ±.02

Results are mean ± S.E., * : Sign of significance, ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the no. of animals died during experiment.

table that hydrocortisone in the dose of 50 mg/kg when given to the rats intraperitonially once in a day for consecutive three days decreased significantly the level of total hexose ($p < .001$), hexosamine ($p < .01$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and thus the total carbohydrate ($p < .001$) of dissolved gastric mucin when compared to the control data. Amlaki (Emblica officinalis Linn.), | amlaki was given orally to the rats in the dose of 1 g/kg once in a day for consecutive three days in addition to hydrocortisone as stated above | treatment, on the other hand, increased significantly the levels of total hexose ($p < .001$), hexosamine ($p < .01$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and thus the total carbohydra ($p < .001$) of dissolved gastric mucin when compared to those values in hydrocortisone treated group.

Phenyl butazone induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin.

Effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in phenyl butazone induced peptic ulcers in guinea-pigs was given in Table 27.

Phenylbutazone (100 mg/kg) when given to the guinea-pigs orally once in a day for consecutive three days caused a significant decrease ($p < .001$) in the levels of hexosamine, methyl pentose, sialic acid and thus in total carbohydrate of dissolved gastr mucin when compared to the control data. Total hexose part of the dissolved gastric mucin, however, did not show any significant change by phenyl butazone.

TABLE - 27 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in phenyl butazone induced peptic ulcers in guinea-pigs.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	30	Nil	0.18 ±.02	0.09 ±.008	0.07 ±.006	0.12 ±.01	0.46 ±.03
PHENYL BUTAZONE	100 mg/kg	32(6)	30.2	0.15 ±.01	0.04*** ±.003	0.03*** ±.002	0.06*** ±.005	0.28*** ±.02
PHENYL BUTAZONE + AMLAKI	100 mg/kg 1 g/kg.	30(2)	12.5	0.17 ±.02	0.08*** ±.007	0.068*** ±.005	0.10** ±.01	0.418** ±.04

Results are mean ± S.E., * : Sign of significance, ** : p /o.01, *** : p / o.001,
Brackets in parenthesis indicate the no. of animals died during experiment.

In addition to phenylbutazone as stated above when amlaki (Emblica officinalis Linn.) was given to the guinea-pigs in the dose of 1 g/kg once in a day for consecutive three days through oral route, significant increase in the levels of hexosamine ($p < .001$), methyl pentose ($p < .001$), sialic acid ($p < .01$) and thus in total carbohydrate ($p < .01$) of dissolved gastric mucin was observed when compared to those values obtained in phenylbutazone treated group. Amlaki treatment, however, did not exert any significant change in the level of total hexose part of dissolved gastric mucin in comparison to the value in phenylbutazone treated group.

Histamine induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin.

Results are given in Table 28. It appears from the table that histamine (33 µg/mouse/day) when given to mice intraperitonially once in a day for consecutive three days, caused a significant decrease in the levels of hexosamine ($p < .001$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and in total carbohydrate ($p < .01$) of dissolved gastric mucin when compared to the control data. Total hexose part of dissolved gastric mucin, however, did not show any significant change by histamine.

When amlaki (Emblica officinalis Linn.) was given to mice orally in the dose of 1 g/kg once in a day for consecutive three days alongwith histamine, significant increase in the levels of hexosamine ($p < .001$), methylpentose ($p < .001$), sialic acid ($p < .001$) and in total carbohydrate ($p < .01$) of dissolved gastric mucin was observed when compared to that of histamine treated group. No

TABLE - 28 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in histamine induced peptic ulcers in mice.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	40	Nil	0.10 ±.01	0.05 ±.004	0.03 ±.002	0.06 ±.005	0.24 ±.03
HISTAMINE	33 µg/ mouse.	46 (5)	25	0.08 ±.007	0.03*** ±.002	0.01*** ±.001	0.03*** ±.002	0.15** ±.01
HISTAMINE + AMLAKI	33 µg/ mouse. 1 g/kg.	50 (2)	9.8	0.08 ±.006	0.05*** ±.003	0.02*** ±.002	0.05*** ±.003	0.20** ±.01

Results are mean ± S.E., * : Sign of significance, ** : $p < 0.01$, *** : $p < 0.001$,
Brackets in parenthesis indicate the no. of animals died during experiment.

significant increase was found in total hexose concentration by amlaki (Emblica officinalis Linn.) .

Restraint ulcer : Effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin.

Effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in restraint ulcers in albino rats are given in Table 29. It appears from the table that restraint stress caused a significant decrease ($p < .001$) in the levels of hexosamine, methyl pentose, sialic acid and in total carbohydrate of dissolved gastric mucin in rats when compared to the control values. Restraint stress, however, did not show any significant change in the level of total hexose of dissolved gastric mucin.

Treatment with amlaki (Emblica officinalis Linn.) | 1 g/kg, once in a day for consecutive three days to the rats orally prior to give the restraint stress, increased significantly ($p < .001$) the levels of hexosamine, methyl pentose, sialic acid and total carbohydrate of dissolved gastric mucin when compared to those values obtained in restraint group. Amlaki treatment, however, did not exert any significant change in the level of total hexose of dissolved gastric mucin.

Shay ulcer : Effect of amlaki (Emblica officinalis Linn.) on dissolved gastric mucin .

Results are given in Table 30. Shay technique, when applied to albino rats, caused a significant decrease ($p < .001$) in the levels of hexosamine, methyl pentose, sialic acid and in total

TABLE - 29 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on the carbohydrate components of dissolved gastric mucin in restraint ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	32	Nil	0.12 ±.02	0.06 ±.005	0.05 ±.005	0.09 ±.007	0.32 ±.03
RESTRAINT	-	38(5)	27	0.10 ±.01	0.03*** ±.002	0.02*** ±.001	0.03*** ±.002	0.16*** ±.01
RESTRAINT + AMLAKI	- 1 g/kg.	35(4)	10.2	0.11 ±.01	0.05*** ±.003	0.05*** ±.004	0.08*** ±.007	0.29*** ±.02

Results are mean ± S.E., * : Sign of significance, ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 30 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of dissolved gastric mucin in Shay ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of dissolved gastric mucin. (mg/mg of mucin)				Amount of mucin represented by total carbohydrate. (mg/mg of mucin)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	30	Nil	0.10 ±.01	0.05 ±.004	0.06 ±.005	0.08 ±.007	0.29 ±.02
SHAY ULCER	-	32(4)	20	0.08 ±.009	0.02*** ±.002	0.02*** ±.001	0.03*** ±.002	0.15*** ±.01
SHAY ULCER + AMLAKI	- 1 g/kg.	33(4)	7	0.09 ±.008	0.06*** ±.005	0.05*** ±.006	0.07*** ±.006	0.27*** ±.02

Results are mean ± S.E., * : Sign of significance, ** : p /0.01, *** : p /0.001,
Brackets in parenthesis indicate the no. of animals died during experiment.

carbohydrate of dissolved gastric mucin when compared to those values for control animals. Total hexose part of dissolved gastric mucin was not effected by Shay technique.

Treatment with amlaki (Emblica officinalis Linn.) | 1 g/kg, once in a day for consecutive three days to the rats orally prior to the application of Shay technique, increased significantly ($p < .001$) the levels of hexosamine, methyl pentose, sialic acid and total carbohydrate of dissolved gastric mucin when compared to those values for 'Shay' group. Total hexose part of dissolved gastric mucin did not show any significant change in this group.

Chapter - IV

STUDIES ON GASTRIC MUCOSAL MUCUS IN EXPERIMENTAL ULCERS : ROLE OF AMLAKI (*Emblica officinalis* Linn.)

C H A P T E R - IV

To study the effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus during experimental ulcerations, collected stomachs (page. 20) were processed by the following methodologies. Nature of ulcerogenic drugs/methods, type of animals, doses of drugs and amlaki (Emblica officinalis Linn.) and their route of administration, duration of aneasthesia and operative techniques were essentially same as described in Chapter - I.

Materials

Essentially same as described in Chapter - III (Page : 43-46).

Methodologies

Collection of gastric mucus from stomach was done by the technique of Menguy [138]. The entire glandular mucosa of clean stomach was scraped off the underlying muscularis. Each mucosal sample was immediately frozen and then lyophilized. After lyophilization, each sample of mucosa was carefully homogenized. One part of the homogenized sample

was then hydrolysed with three parts of 6(N) hydrochloric acid at 100°C for two hours to release neutral and amino sugars[134]. The hydrolysates were neutralised with 0.1(N) sodium hydroxide, volume made upto 3 ml and 1 ml each was utilized for the estimation of total hexose[137], hexosamine[136] and methyl pentose[137]. Remaining part of the homogenized sample was hydrolysed with its three volume of 0.1 (N) sulphuric acid at 100°C for one hour to liberate the sialic acid[134]. The hydrolysate was neutralised with 0.1(N) sodium hydroxide, volume made upto 1 ml and was used for the estimation of sialic acid by thiobarbituric acid method of Warren[135].

Methodologies for the estimation of total hexose, hexosamine, methyl pentose and sialic acid were essentially same as described in Chapter - III (Page : 47 - 51).The sum of total hexose, hexosamine, methyl pentose and sialic acid i.e. total carbohydrate was taken as the index of the level of gastric mucus as suggested by Menguy[5], was expressed in terms of µg/mg of dry tissue.

Student's 't' test was applied to evaluate the data.

Results

Results are given in and from Table 31 to Table 40.

Aspirin induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucus in aspirin induced peptic ulcers in albino rats was given in Table 31.

It appears from the table that aspirin (100 mg/kg), when given to the rats intraperitonially once in a day for consecutive

TABLE -31 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucus in aspirin induced peptic ulcers in albino rats.

Group	No. of animals.	Dose used.	Ulcer index.	Carbohydrate components of gastric mucosal mucus (µg/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (µg/mg of dry tissue)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	25	-	Nil	20.1 ±3	18.2 ±2.1	5.2 ±.6	2.1 ±.3	45.6 ±4.5
ASPIRIN	30(5)	100 mg/kg.	23.1	8.2** ±2	10.1** ±1.1	2.2** ±.8	0.9*** ±.09	21.4*** ±2.1
ASPIRIN + AMLAKI	32(2)	100 mg/kg + 1 g/kg	11.2	18.8** ±2.5	20.1*** ±2	6.0** ±.8	2.0** ±.3	46.9*** ±4.2

Results are mean ± S.E., * : Sign of significance, ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the animals died during experiment.

three days caused a significant decrease in the levels of total hexose ($p < .01$), hexosamine ($p < .01$), methyl pentose ($p < .01$), sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of gastric mucosal mucus when compared to those values for control animals. Amlaki (Emblica officinalis Linn.) treatment | 1 g/kg given orally to the rats once in a day for consecutive three days alongwith aspirin |, on the other hand, increased significantly the levels of total hexose ($p < .01$), hexosamine ($p < .001$), methyl pentose ($p < .01$), sialic acid ($p < .01$) and thus the total carbohydrate ($p < .001$) of gastric mucosal mucin when compared to those of aspirin treated group.

Salicylic acid induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucin.

Results are given in Table 32. It appears from the table that salicylic acid (100 mg/kg) when given to albino rats intraperitonially once in a day for three consecutive days, decreased significantly the levels of total hexose ($p < .01$), hexosamine ($p < .01$) methyl pentose ($p < .025$), sialic acid ($p < .001$) and thus the total carbohydrate ($p < .001$) of gastric mucosal mucin when compared to the control data. Alongwith salicylic acid in the dose stated above when amlaki (Emblica officinalis Linn.) was given orally to the rats in the dose of 1 g/kg once in a day for consecutive three days, significant increase in the levels of total hexose ($p < .01$), hexosamine ($p < .01$), methyl pentose ($p < .025$), sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of gastric mucosal mucin was observed when compared with those values in salicylic acid group.

TABLE - 32 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucus in salicylic acid induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucus. /ug/mg of dry tissue				Amount of mucus represented by total carbohydrate. (/ug/mg of dry tissue)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	30	Nil	19.9 ±2.9	18.0 ±2.2	6.0 ±0.7	3.0 ±0.29	46.9 ±4.8
SALICYLIC ACID	100 mg/kg	32(6)	24	** 8.0 ±2.1	** 11.0 ±1.2	* 3.2 ±0.82	*** 1.0 ±0.02	*** 23.2 ±2.1
SALICYLIC ACID + AMLAKI	100 mg/kg 1 g/kg	30(3)	13.4	** 17.8 ±2.6	** 17.0 ±1.7	* 5.8 ±0.62	*** 3.1 ±0.3	*** 43.7 ±4.0

Results are mean ± S.E., * : Sign of significance, * : p /0.025, ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the no. of animals died during experiment.

Paracetamol induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Results are given in Table 33. When paracetamol (100 mg/kg) was given to albino rats intraperitonially once in a day for consecutive three days, significant decrease was observed in the levels of total hexose ($p < .01$), hexosamine ($p < .025$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of gastric mucosal mucose when compared to the control data. Amlaki (Emblica officinalis Linn.) treatment | 1 g/kg, once in a day for consecutive three days orally | alongwith the aforesaid doses of paracetamol, on the other hand, significantly increased the levels of total hexose ($p < .01$), hexosamine ($p < .025$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and thus in total carbohydrate of gastric mucosal mucose when compared to these values obtained in paracetamol treated rats.

Indomethacin induced ulcers : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Results are given in Table 34. It appears from the table that significant decrease was observed in the levels of total hexose ($p < .025$), hexosamine ($p < .01$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and thus in total carbohydrate ($p < .001$) of g gastric mucosal mucus in comparison to control data when rats received indomethacin (25 mg/kg) intraperitonially once in a day for consecutive three days. When amlaki (Emblica officinalis Linn.) in the dose of 1 g/kg was given orally to the rats once in a day for three consecutive days alongwith indomethacin, significant increase was foun

TABLE - 33 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on the carbohydrate components of gastric mucosal mucus in paracetamol induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucus. (µg/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (µg/mg of dry tissue)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	29	Nil	18.2 ±2.8	17.5 ±2.3	5.8 ±0.6	2.9 ±0.22	44.4 ±4.2
PARACETAMOL	100 mg/kg	35(6)	25	** 8.0 ±1.9	* 10.8 ±1.5	*** 3.0 ±0.4	*** 1.1 ±0.1	*** 22.9 ±2.1
PARACETAMOL + AMLAKI	100 mg/kg 1 g/kg.	33(2)	8.3	** 17.9 ±2.0	* 17.2 ±2.1	*** 6.0 ±0.5	*** 3.2 ±0.3	*** 44.3 ±5.0

Results are mean ± S.E., * : Sign of significance, * : $p < 0.025$, ** : $p < 0.01$, *** : $p < 0.001$. Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 34 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucus in indomethacin induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucus. (µg/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (µg/mg of dry tissue)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	26	Nil	17.0 ±2.5	16.8 ±2.0	6.0 ±0.52	3.0 ±0.25	42.8 ±4.0
INDOMETHACIN	25 mg/kg	28(2)	27.5	* 8.8 ±1.7	** 10.0 ±1.2	*** 3.2 ±0.29	*** 1.5 ±0.12	*** 23.5 ±2.3
INDOMETHACIN + AMLAKI	25 mg/kg + 1 g/kg	25(1)	11	** 16.8 ±1.8	* 16.0 ±1.9	*** 5.8 ±0.60	*** 2.9 ±0.21	*** 41.5 ±4.2

Results are mean ± S.E., * : Sign of significance, * : p /0.025, ** : p /0.01, *** : p /0.001. Brackets in parenthesis indicate the no. of animals died during experiment.

in the levels of total hexose ($p < .01$), hexosamine ($p < .025$), methyl pentose ($p < .001$), sialic acid ($p < .001$) - thus in total carbohydrate ($p < .001$) of gastric mucosal mucin when compared to those values obtained in indomethacin group.

Prednisolone induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucus in prednisolone induc -ed peptic ulcers in albino rats was given in Table 35.

Prednisolone in the dose 30 mg/kg, when given to rats intraperitonially once in a day for consecutive three days, decreased significantly the levels of total hexose ($p < .025$), hexosamine ($p < .01$), methyl pentose ($p < .001$), sialic acid ($p < .001$) - thus the total carbohydrate ($p < .001$) of gastric mucosal mucus in comparison to the control values. When amlaki (Emblica officinalis Linn.) was given to the rats orally in the dose 1 g/kg once in a day for consecutive three days alongwith the aforesaid dose of prednisolone, significant increase was found in the levels of total hexose ($p < .01$), hexosamine ($p < .001$), methyl pentose ($p < .001$), sialic acid ($p < .001$) thus in total carbohydrate($p < .001$) of gastric mucosal mucus when compared with the values obtained in prednisolone group.

Hydrocortisone induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Results are given in Table 36.

A significant decrease was noticed in the levels of

TABLE - 35 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucus in prednisolone induced peptic ulcers in albino rats.

Group	Drug used.	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucus. (/ug/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (/ug/mg of dry tissue)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	30	Nil	20.0 ±3.2	18.0 ±2.0	5.5 ±0.6	2.8 ±0.2	46.3 ±5.0
PREDNISOLONE	30 mg/kg	33(4)	22.4	* 18.2 ±2.0	** 10.0 ±1.0	*** 2.5 ±0.24	*** 1.0 ±0.1	*** 23.7 ±2.0
PREDNISOLONE + AMLAKI	30 mg/kg 1 g/kg	37(2)	8.2	** 18.0 ±1.8	*** 17.0 ±1.1	*** 5.0 ±0.58	*** 2.6 ±0.23	*** 42.6 ±4.5

Results are mean ± S.E., * : Sign of significance, * : p /0.025, ** : p /0.01, *** : p /0.001. Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 36 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucosa in hydrocortisone induced peptic ulcers in albino rats.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucus. (/ug/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (/ug/mg of dry tissue)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	25	Nil	18.8 ±3.5	17.2 ±3.5	5.0 ±0.52	3.0 ±0.32	44.0 ±4.8
HYDROCORTISONE	50 mg/kg	28(2)	26	9.0* ±2.0	9.2 ±2.0	2.8*** ±0.2	1.5*** ±0.1	22.5*** ±2.2
HYDROCORTISONE + AMLAKI	50 mg/kg 1 g/kg	28(0)	10	17.5** ±2.2	15.6 ±2.8	5.1*** ±0.42	2.9*** ±0.22	41.1*** ±3.7

Results are mean ± S.E., * : Sign of significance, * : p /0.025, ** : p /0.01, *** : p /0.001. Brackets in parenthesis indicate the no. of animals died during experiment.

total hexose ($p < .025$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and in total carbohydrate ($p < .001$) of gastric mucosal mucus in hydrocortisone treated rats in comparison to control data. Hydrocortisone (50 mg/kg) was given to rats intreperitonially once in a day for consecutive three days. This dose of hydrocortisone, however, did not exert any effect on the level of hexosamine of gastric mucosal mucus.

In addition to this dose of hydrocortisone when amlaki (Emblica officinalis Linn.) | 1 g/kg/day | was given to rats orally once in a day for consecutive three days, significant increase was found in the levels of total hexose ($p < .01$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and in total carbohydrate ($p < .001$) of gastric mucosal mucus when compared to the values of hydrcortisone group. Hexosamine part of gastric mucosal mucus did not show any significant change by amlaki (Emblica officinalis Linn.).

Phenyl butazone induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Results related to the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucus in phenyl butazone induced peptic ulcers in guinea-pigs are given in Table 37. It appears from the table that phenyl butazone (100 mg/kg) when given to guinea-pigs orally once in a day for consecutive three days caused a significant decrease in the levels of total hexose ($p < .025$), methyl pentose ($p < .001$), sialic acid ($p < .001$) and in total carbohydrate ($p < .001$) of gastric mucosal mucus in comparison to control data. Hexosamine of gastric mucosal mucus, however, did not show any change by phenyl butazone.

TABLE - 37 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucose in phenyl butazone induced peptic ulcers in guinea-pigs.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucose. (/ug/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (/ug/mg of dry tissue).
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	30	Nil	22.5 ±4.0	20.0 ±3.2	7.2 ±0.62	5.2 ±0.5	54.9 ±5.8
PHENYLBUTAZONE	100 mg/kg	32(6)	30.2	* 10.0 ±2.0	11.2 ±2.0	*** 4.0 ±0.4	*** 2.8 ±0.2	*** 28.0 ±2.0
PHENYLBUTAZONE + AMLAKI	100 mg/kg 1 g/kg	30(2)	12.5	* 20.8 ±3.8	18.9 ±3.0	*** 7.0 ±0.68	*** 5.0 ±0.48	*** 51.7 ±4.7

Results are mean ± S.E., * : Sign of significance, * : p /0.025, ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the no. of animals died during experiment.

When amlaki (Emblica officinalis Linn.) in the dose of 1 g/kg was given to guinea-pigs orally once in a day for consecutive three days alongwith the aforesaid dose of phenylbutazone, significant increase was observed in the levels of total hexose ($p < .02$, methyl pentose ($p < .001$), sialic acid ($p < .001$) and in total carbohydrate ($p < .001$) of gastric mucosal mucus in comparison to the values in phenyl butazone group. Hexosamine of gastric mucosal mucus was not affected by amlaki (Emblica officinalis Linn.) treatment.

Histamine induced ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Results are given in Table 38. Histamine (33 µg/ mouse) when given to mice intraperitonially once in a day for consecutive three days, decreased significantly the levels of total hexose ($p < .025$), hexosamine ($p < .01$), methyl pentose ($p < .01$), sialic acid ($p < .001$) thus the total carbohydrate ($p < .001$) of gastric mucosal mucus when compared to those of control data. Alongwith histamine when the mice received amlaki (Emblica officinalis Linn.) in the dose of 1 g/kg once in a day for consecutive three days through oral route, significant increase in the levels of hexosamine ($p < .01$), methyl pentose ($p < .025$), sialic acid ($p < .001$) and in total carbohy--drate ($p < .001$) of gastric mucosal mucus was observed when compared to the values in histamine group. Total hexose part of gastric mucosal mucus, however, was not affected by amlaki (Emblica officinalis Linn.)

Restraint ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Results are given in Table 39. Restraint stress

TABLE - 38 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucosa in histamine induced peptic ulcers in mice.

Group	Dose used.	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucus. (/ug/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (/ug/mg of dry tissue)
				Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	-	40	Nil	15.2 ±1.8	14.0 ±1.8	5.0 ±0.52	2.5 ±0.26	36.7 ±3.5
HISTAMINE	33 /ug/ mouse.	46(5)	25	* 10.2 ±2.0	** 7.0 ±0.80	** 3.2 ±0.3	*** 1.2 ±0.1	*** 21.6 ±2.0
HISTAMINE + AMLAKI	33 /ug/ mouse 1 g/kg	50(2)	9.8	14.8 ±2.0	** 13.5 ±2.2	* 4.8 ±0.4	*** 2.2 ±0.2	*** 35.3 ±3.0

Results are mean ± S.E.; * : Sign of significance, * : p /0.025, ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 39 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on the carbohydrate components of gastric mucosal mucosa in restraint ulcers in albino rats.

Group	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucus. (µg/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (µg/mg of dry tissue)
			Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	32	Nil	18.2 ±2.1	16.8 ±1.8	5.2 ±0.62	3.3 ±0.31	43.5 ±4.1
RESTRAINT	38(5)	27	*** 9.0 ±1.0	*** 9.2 ±0.8	** 3.2 ±0.3	*** 2.0 ±0.18	*** 23.4 ±2.2
RESTRAINT + AMLAKI (Dose used, 1g/kg)	35(4)	10.2	*** 18.0 ±1.9	** 16.2 ±1.9	** 5.0 ±0.5	** 3.0 ±0.29	*** 42.2 ±4.0

Results are mean ± S.E., * : Sign of significance, * : $p < 0.025$, ** : $p < 0.01$, *** : $p < 0.001$.
Brackets in parenthesis indicate the no. of animals died during experiment.

TABLE - 40 : Showing the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucose in Shay ulcers in albino rats.

Group	No. of animals.	Ulcer index.	Carbohydrate components of gastric mucosal mucus. (/ug/mg of dry tissue)				Amount of mucus represented by total carbohydrate. (/ug/mg of dry tissue).
			Total hexose.	Hexose amine.	Methyl pentose.	Sialic acid.	
CONTROL	30	Nil	17.8 ±2.0	17.0 ±1.9	5.8 ±0.60	3.0 ±0.30	43.6 ±4.2
SHAY ULCER	32(4)	20	*** 9.2 ±2.0	*** 8.0 ±0.7	*** 3.1 ±0.3	*** 1.8 ±0.1	*** 22.1 ±2.0
SHAY ULCER + AMLAKI (Dose used, 1g/kg)	33(4)	7	*** 18.0 ±2.1	*** 16.8 ±1.8	*** 5.2 ±0.42	*** 2.9 ±0.12	*** 42.9 ±4.1

Results are mean ± S.E., * : Sign of Significance, * : p /0.025, ** : p /0.01, *** : p /0.001.
Brackets in parenthesis indicate the no. of animals died during experiment.

in albino rats caused a significant decrease in the levels of total hexose ($p < .001$), hexosamine ($p < .001$), methyl pentose ($p < .01$), sialic acid ($p < .001$) and in total carbohydrate ($p < .001$) of gastric mucosal mucus in comparison to control values. Alongwith restraint stress when amlaki (Emblica officinalis Linn.) was given to rats (it was given in the dose of 1 g/kg, once in a day for consecutive three days prior to give restraint stress) through oral route, significant increase was observed in the levels of total hexose ($p < .001$), hexosamine ($p < .01$), methyl pentose ($p < .01$), sialic acid ($p < .01$) and thus in total carbohydrate ($p < .001$) of gastric mucosal mucus.

Shay ulcer : Effect of amlaki (Emblica officinalis Linn.) on gastric mucosal mucus.

Results related to the effect of amlaki (Emblica officinalis Linn.) on the carbohydrate components of gastric mucosal mucus in Shay ulcers in albino rats are given in Table 40. It appears from the table that Shay technique when applied to rats caused a significant decrease ($p < .001$) in the levels of total hexose, hexosamine, methyl pentose, sialic acid and thus in total carbohydrate of gastric mucosal mucus when compared the values with control data. Pretreatment with amlaki (Emblica officinalis Linn.) in the dose 1g/kg orally once in a day for consecutive three days before the application of Shay technique caused a significant increase ($p < .001$) in the levels of total hexose, hexosamine, methyl pentose, sialic acid and thus in total carbohydrate of gastric mucosal mucus in comparison to those values obtained in 'Shay group'.

D I S C U S S I O N

D I S C U S S I O N

Amlaki-tree is common in the mixed deciduous forests of India ascending to 4,500 ft on the hills. It is often cultivated in gardens and honeyards. Fruit amlaki (Emblica officinalis Linn.) in different Indian languages is called as under[139] :

In bengali and uriya : Amlaki

In hindi and punjabi : Amla

In malayalam and tamil : Nelli

In sanscrit and kanada : Amalaka

In telegu : Amalakamu

In santal : Meral

In assam : Amluki

Fruit 'Amlaki'(Emblica officinalis Linn.) has a sour, astringent taste riches in tanin and vitamin C. It has both diuretic and laxative property. When dried, the fruit is useful in haemorrhage, diarrhoea and dysentery. In combination with iron [redacted]

the fruit is used in jaundice, dyspepsia and cough. Sherbet of the fruit with lemon juice is taken to arrest acute bacillary dysentery. Exudation from incisions on the fruit is used as external application for the inflammation of the eye. As a good source of vitamin C the fruit is successfully used in the treatment of human scurvy. Considering all these medicinal properties, the fruit is being used as a common medicine in Indian households.

In addition to these medicinal properties of amlaki (Emblica officinalis Linn.) , it has been recently demonstrated by Verma et al.[123] that the fruit is beneficial for peptic ulcer patients. Radiologically proved peptic ulcer patients when took 'Amlaki Rasayana' | an indigenous medicine main ingredient of which is amlaki (Emblica officinalis Linn.) | for a period of three months got relief at least symptometically. In certain cases healing of ulcer was evident in X-ray plate. Experimental work demonstrating antiulcerogenic property of amlaki (Emblica officinalis Linn.), however, was not observed in the available literature.

It was thus thought worthwhile to study the antiulcerogenic effect of amlaki (Emblica officinalis Linn.) in experimental animals. In a pilot experiment we studied this on aspirin induced peptic ulcers in albino rats. We observed a significant reduction in the incidence of gastric ulcers when the animals were treated with amlaki (Emblica officinalis Linn.) . This pilot study tempted us to undertake this project in detail where we studied the role of amlaki (Emblica officinalis Linn.) on various experimental ulcer models as induced by :

1. Aspirin

2. Salicylic acid
3. Paracetamol
4. Indomethacin
5. Prednisolone
6. Hydrocortisone
7. Phenyl butazone
8. Histamine
9. Restraint stress
10. Shay technique

ASPIRIN INDUCED ULCER : ROLE OF AMLAKI (Emblica officinalis Linn.)

It appears from the result (Table 1) that in albino rats aspirin in the dose of 100 mg/kg induced ulcers in the glandular portion of stomach and the stomach was invariably accompanied by frank intragastric haemorrhage - an earlier observation made by Brodie and Chase[34] , Djahanguiri[35] using different doses of aspirin.Our study also confirmed that amlaki (Emblica officinalis Linn.) diet significantly reduced the incidence of aspirin induced gastric ulcers.

While studing the effect of aspirin on the rate of gastric secretion, gastric acidity and peptic activity Paul et al.[37] observed that aspirin causes a decrease in volume and acidity of gastric secretion while Lynch et al.[36] observed an increase, no change or a decrease in gastric secretion and gastric acidity by aspirin depending on the dose and species studied. We, however, observed no significant change in volume, acidity and peptic activity of gastric secretion by the dose of aspirin (100 mg/kg, intraperitonially once in a day for consecutive three days) we used in albino rats. Effect of

amleki (Emblica officinalis Linn.) diet on the said parameters was also not significant although a decreasing trend in the volume, acidity and peptic activity of the gastric secretion in comparison to that of aspirin treated group was observed.

That aspirin reduces the secretion of gastric mucus was an earlier observation made by Menguy and his group of workers[41]. We also found that aspirin reduced the amount of dissolved gastric mucin as well as gastric mucosal mucose. The constituent carbohydrate components of dissolved gastric mucin and mucosal mucus viz. total hexose, hexosamine, methyl pentose, sialic acid etc. showed a significant ($p < .01$ to $p < .001$) decrease in levels. The amount of dissolved mucin and mucosal mucus as represented by total carbohydrate[41] also showed significant decrease ($p < .001$) by aspirin. Amleki (Emblica officinalis Linn.) treatment, on the other hand, increased the levels of all these constituent carbohydrate components and thus the total carbohydrate of dissolved gastric mucin and gastric mucosal mucus.

SALICYLIC ACID INDUCED ULCER : ROLE OF AMLAKI (Emblica officinalis Linn.)

Brodie and Chase[34], while working on the ulcerogenic role of salicylic acid in rat, observed a dose dependent response of salicylic acid in the production of gastric ulcer. We in our study noticed (Table 2) that salicylic acid in the dose 100 mg/kg when given to rats intraperitonially once in a day for consecutive three days produced profuse ulcers in the glandular part of stomach. Ulcers were associated with frank intragastric haemorrhage. Dodd et al.[48] also found the intragastric haemorrhage associated with ulcers induced by salicylic acid.

Reports on the effect of salicylic acid on gastric volume, acidity and peptic activity are conflicting. Lish et al.[38] reported, salicylic acid causes a decrease in volume and acidity of the gastric secretion while Winkelman and Summerskill[39] found that salicylic acid has no effect on rate of gastric secretion and gastric acidity. We in this study also observed that salicylic acid had no significant effect on rate of gastric secretion, gastric acidity and peptic activity. Treatment with amlaki (Emblica officinalis Linn.) had also no effect on the said parameters.(Table 12)

With the aforesaid dose of salicylic acid we observed a significant decrease in the levels of gastric dissolved mucin and gastric mucosal mucus when measured the constituent carbohydrate components like total hexose, hexosamine, methyl pentose and sialic acid (Table :22, Table :32). Kent and Allen[42] also observed a reduction in the rate of synthesis and secretion of mucus by salicylic acid. They thus said, 'It is the loss of mucus barrier that permits the toxic effects of salicylic acid to produce ulcers in stomach'. These decreased levels of gastric dissolved mucin and gastric mucosal mucus during salicylic acid induced ulcers were increased significantly (Table:22, Table:32) when the rats were treated with amlaki (Emblica officinalis Linn.).

PARACETAMOL INDUCED ULCERS : ROLE OF AMLAKI (Emblica officinali Linn.)

Studies on paracetamol for its ulcerogenic potency are few in the available literature. Proudfoot and Wright[51] when studied the cases of acute paracetamol poisoning noticed

gastrointestinal haemorrhage. We found the presence of massive ulcers at the glandular part of the stomach of rats when the animals were treated by paracetamol (100 mg/kg) intraperitonially once in a day for consecutive three days. Ulcers were associated with frank intragastric haemorrhage. When amlaki (Emblica officinalis Linn.) was given to the rats orally in the dose of 1 g/kg once in a day for consecutive three days in addition to the scheduled doses of paracetamol, we observed a significant decrease in the incidence of ulcers and its severity (Table : 3). This antiulcerogenic property was not related to acid-peptic digestion as we did not observe any significant changes in gastric volume, acidity and peptic activity after amlaki (Emblica officinalis Linn.) treatment |Table : 13 |. Rather, this antiulcerogenic property of amlaki (Emblica officinalis Linn.) was found related to mucus secretion as levels of gastric dissolved mucin and gastric mucosal mucus increased significantly when the rats received amlaki (Emblica officinalis Linn.) diet. Considering the mucus 'barrier' hypothesis of Menguy[41] it can thus be stated that amlaki (Emblica officinalis Linn.) increases the level of mucus which resists the toxic effects of paracetamol to induce ulcers in the stomach.

INDOMETHACIN INDUCED ULCER : EFFECT OF AMLAKI (Emblica officinali Linn.)

In animal experiments, Djahanguiri[74] and Lee et [7] showed that indomethacin caused gastric, duodenal, antral and jejunal ulcerations, haemorrhage and perforation. On studing this ulcerogenic property, Nicolff[76] showed that ulcerogenic effect of indomethacin did not seem to be related to acid hypersecretion.

On the other hand, Menguy[41] observed that ulcerogenic effect of indomethacin was related to mucus secretion as it lowered the rate of mucus secretion and diminished the amount of carbohydrate incorporation into the mucosubstance, which helped the drug to exert its toxic effect to damage the mucosa.

In our experiment we observed that indomethacin in the dose of 25 mg/kg when given to rats intraperitonially once in a day for consecutive three days formed several ulcers at the glandular region of stomach (Table : 4). This ulcer formation was not related with acid-peptic digestion since in the aforesaid dose indomethacin had no effect on rate of gastric secretion, gastric acidity and peptic activity. (Table : 18)

On the other hand, we observed, indomethacin had a relation with gastric mucus secretion since it decreased the levels of total hexose, hexosamine, methyl pentose and sialic acid (the constituent carbohydrate components of mucin) and thus the levels of dissolved gastric mucin and gastric mucosal mucus (Table:24 & 34). Our study thus confirmed the earlier observation of Menguy[41].

When amlaki (Emblica officinalis Linn.) was given to rats orally in the dose of 1 g/kg once in a day for consecutive three days, we found a significant reduction in the incidence of ulceration by indomethacin (Table : 4). We observed that there was no change in the acid-peptic value by amlaki (Emblica officinalis Linn.) but significant increase was found in the levels of dissolved gastric mucin and gastric mucosal mucose. Thus, antiulcerogenic effec of amlaki (Emblica officinalis Linn.) in indomethacin induced gastric ulcers can be explained in terms of mucus secretion (Defensive factor

PREDNISOLONE INDUCED ULCER : ROLE OF AMLAKI (Emblica officinalis Linn.)

Several reports[54-57] are available in literature showing the ulcerogenic potency of prednisolone in experimental animals. In rats, it is stated, prednisolone induced profuse gastric ulcers. We also observed the presence of ulcers at glandular part of stomach of rats when the animals received prednisolone (30 mg/kg) intraperitonially once in a day for consecutive three days(Table:5). 4 rats out of 33, died during experiment, showed the extension and perforation of ulcers . This finding was in agreement with the earlier reported observation of Kaham et al.[61]

When studied the effect of prednisolone on acid-peptic as well as mucus factor, we found that this drug had no effect on rate of gastric secretion, gastric acidity and peptic activity. But the mucus factor represented by the levels of dissolved gastric mucin and gastric mucosal mucosa was found significantly decreased by prednisolne. Earlier, this was observed by Seyle[64] who stressed on the fact that diminution of tissue resistance is related to the anti-inflammatory action of corticosteroids in the genesis of ulceration.

We noticed the antiulcerogenic effect of amlaki (Emblica officinalis Linn.) in this experimental ulcer model as amlaki-diet in the dose of 1 g/kg, orally, once in a day for consecutive three days significantly reduced the incidence of prednisolone induced ulcer in rats. (Table :5). Sanyal et al. observed the same effect for vegetable banana[28]. This antiulcerogenic

property of amlaki (Emblica officinalis Linn.) had a relation with mucus factor and not with acid-peptic factor since we found that this indigenous fruit increased the mucus secretion in ulcerated stomach (Table : 25 and 35) but had no effect on gastric acidity and peptic activity (Table : 15).

HYDROCORTISONE INDUCED ULCER : ROLE OF AMLAKI (Emblica officinali Linn.)

Table 06, showing the effect of amlaki (Emblica officinalis Linn.) on hydrocortisone induced ulcers in albino rats reveals that hydrocortisone acetate in the dose of 50 mg/kg/day when given to rats intraperitonially once in a day for consecutive three days produced massive ulcers of different size at the glandular region of stomach. Ulcerogenic potency of hydrocortisone in man as well as in experimental animals has been stated earlier elsewhere[58-60]. We observed that this ulcerogenic dose of hydrocortisone had no effect on the rate of gastric secretion, gastric acidity and peptic activity (Table : 16) but decreased the levels of dissolved gastric mucin and gastric mucosal mucus (Table : 26, 36). All the carbohydrate components like total hexose, hexosamine, methyl pentose and sialic acid were found in less amount in gastric juice and gastric mucosa after the administration of hydrocortisone. Importance of mucus secretion during hydrocortisone induced ulcers was noted by Seyle[64].

Antiulcerogenic effect of amlaki (Emblica officinalis Linn.) on hydrocortisone induced ulcers was evident from our study. We observed a significant reduction in the incidence of gastric ulcers in albino rats as induced by hydrocortisone, when amlaki diet was given to rats in a specific dose (1 g/kg, once in a day for consecutive three days orally). (Table : 6). This

antiulcerogenic effect of amlaki (Emblica officinalis Linn.) , we observed, had a relation with mucus secretion since the levels of dissolved gastric mucin and gastric mucosal mucosa in ulcerated stomach were increased significantly by amlaki (Emblica officinalis Linn.) (Teble : 26,36).

PHENYLBUTAZONE INDUCED ULCER : ROLE OF AMLAKI (Emblica officinal Linn.)

Phenylbutazone in the dose of 100 mg/kg when given to guinea-pigs orally once in a day for consecutive three days produced profuse ulcers at the glandular part of stomach (Figure:1). Ulcers were associated with pathologies like frank intragastric haemorrhage, adhesion and acute dilatation of the blood vessels, (Teble : 7). Animals, died during experiment, showed the presence of big penetrating ulcers as well as perforation of ulcer. All these observations are in confirmatory with the earlier reported findings.[82-84]

On studing the cause of phenylbutazone induced ulcers, Schimid et al.[85] reported that phenyl butazone stimulated both gastric acid secretion and peptic activity of the gastric juice, while Bonfils[86] did not observe any significant change in gastric acid secretion after oral or parenteral administration of the drug. We also did not observe any significant effect of phenyl butazone on rate of gastric secretion, gastric acidity and peptic activity (Teble :17), rather this drug decreased the levels of all the constituent carbohydrates (Total hexose, hexosamine, methyl pentose and sialic acid) of dissolved gastric mucin and gastric

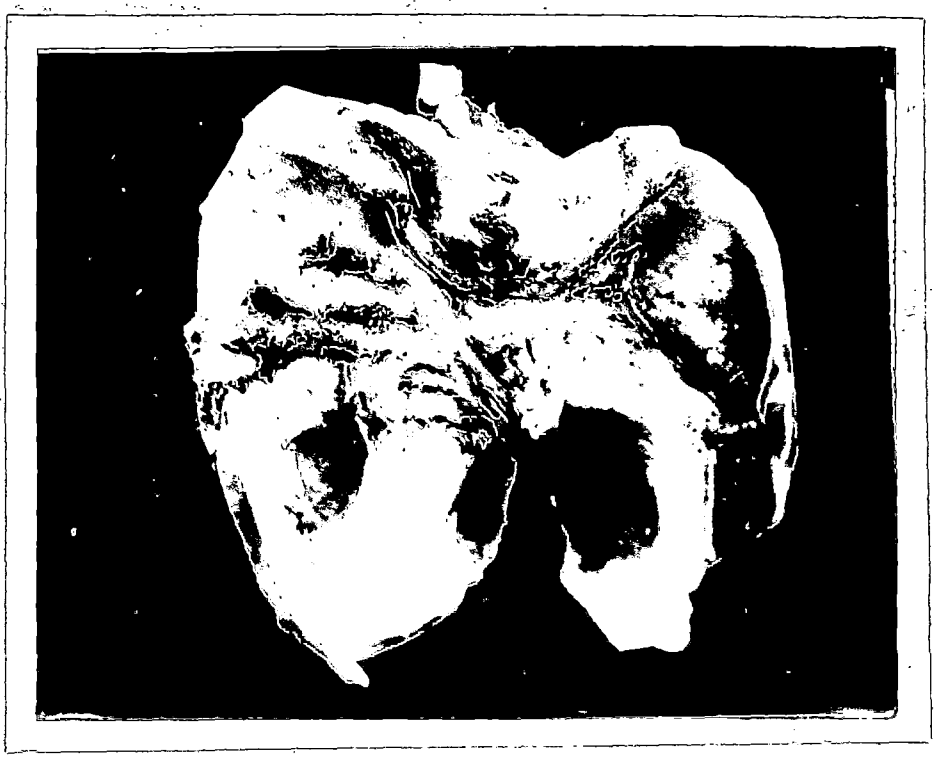

FIGURE-1 : Showing phenylbutazone induced ulcers in the stomach of guinea-pig.

FIGURE-2 : Showing the effect of amlaki (*Emblica officinalis* Linn.) on phenylbutazone induced ulcers in the stomach of guinea-pig.

mucosal mucus (Table : 27 and 37). Zaidi et al.[91] also observed a steady decreese of mucin in the gastric juice after 30 days of phenylbutazone treatment in guineapigs.

Antiulcerogenic effect of amlaki (Emblica officinalis Linn.) on phenylbutazone induced ulcer in guinea-pigs can be noted from Figure : 2. It was found out that amlaki-diet (1 g/kg, orally once in a day for consecutive three days) significan-tly reduced the incidence of phenylbutazone induced ulceration and its severity (Table : 7). It was also observed that this antiulcero-genic property had no relation with gastric acidity and peptic activity (Table : 17) but had a relation with gastric mucus (Table : 27, 37). It was found out that amlaki (Emblica officinalis Linn.) in the aforesaid dose had no effect on gastric secretion and acidity but increased significantly the levels of dissolved gastric mucin as well as gastric mucosal mucus during ulceration.

HISTAMINE INDUCED ULCERS : EFFECT OF AMLAKI (Emblica officinalis Linn.)

There are reports that histamine in specific dose when administered through specific route caused gastric and duodenal ulcers in man and animals[63,122]. Ulcerogenic potency of the drug was related to gastric hypersecretion. In our experiment when histamine (33 µg/mouse) was given to the mice intraperitonially once in a day for consecutive three days, severe ulcers were noted at the glandular part of the stomach . Ulcers were associated with haemorrhage and other pathologies like adhesion and acute dilatation of the blood vessels (Table : 8). We, however, did not observe any

change in the rate of gastric secretion, gastric acidity and peptic activity by the aforesaid dose of histamine indicating thereby the probable dose dependent response on these parameters by the drug. On the other hand, we found a significant decrease in the levels of dissolved gastric mucin and gastric mucosal mucus in ulcerated stomach caused by histamine. (Table : 18, 28, 38).

Effect of banana-diet on histamine induced gastric ulcers in mice was studied by Elliott and Heward[122]. These workers noted that pretreatment of mice with banana diet caused a significant reduction in the incidence of histamine induced ulcers. We also noted the same thing. We gave amleki (Emblica officinalis Linn.) diet (1 g/kg, orally once in a day for consecutive three days alongwith histamine) to the mice and observed a significant reduction (70%) in the incidence of ulceration induced by histamine. We found that this antiulcerogenic effect of amleki (Emblica officinalis Linn.) was not related with acid-peptic factor since amleki-diet could not exert any significant change in the rate of gastric secretion, gastri acidity and peptic activity during ulceration (Table : 18). Rather, amleki (Emblica officinalis Linn.) exerted a significant increase in the levels of hexosamine, methyl pentose and sialic acid of dissloved gastric mucin and gastric mucosal mucus. This increased mucus levels during ulceration might give a protective barrier to the stomach wall which resisted the toxic effect of histamine for forming ulcer as reported elsewhere[41].

RESTRAINT ULCER : ROLE OF AMLAKI (Emblica officinalis Linn.)

Table : 9 clearly shows the effect of restreint

stress and the effect of amlaki (Emblica officinalis Linn.) towards the production of gastric ulcer. We found that restraint stress induced gastric ulcers (at the glandular part of stomach) in rats. Incidence of ulceration was 100%. Most of the ulcers were associated with intragastric haemorrhage, perforation, adhesion and acute dilatation of the blood vessels. Earlier Brodie and Hanson as well as Rossi et al. developed restraint ulcers in experimental animals[24,95]. On studing the mechanism of restraint ulcers, Menguy[27] did not found any change in the acid-peptic output by restraint stress. Thus, he concluded that acid-peptic digestion was not the basic mechanism in the production of restraint ulcers. Brodie et al.[24,98], on the other hand, found an increase in the concentration of gastric acid during restraint ulcers. In our study, we however did not notice any change in the rate of gastric secretion, gastric acidity and peptic activity during restraint ulceration (Table : 19). Working on gastric mucosa in restraint ulcer, Hase and Moss[103] noted the microvascular changes in gastric mucosa in the development of restraint ulcer in rats. We observed that restraint stress decreased the levels of dissolved gastric mucin and gastric mucosal mucus which helped to develop the ulcers in the stomach (Table : 29, 39).

Effect of indigenous fruit on restraint ulcers was ,for the first time, studied by Senyal et al.[28] They worked on unripe vegetable banana and found that banana could prevent the incidence of restraint ulcers. In the present study we, when given amlaki (Emblica officinalis Linn.) to the rats orally in the dose of 1 g/kg once in a day for consecutive three days prior to give the restraint stress, observed that amlaki (Emblica officinalis Linn.)

reduced the incidence and severity of restraint ulcers by about 80%. This antiulcerogenic effect was not found related with gastric acidity or peptic activity since amlaki (Emblica officinalis Linn.) could not exert any significant effect on rate of gastric secretion, gastric acidity and peptic activity. On the other hand, we observed * amlaki-diet could increase the levels of constituent carbohydrate components viz. total hexose, hexosamine, methyl pentose, sialic acid etc. of dissolved gastric mucin and gastric mucosal mucus during ulceration ($p < .025$ to $p < .001$). This increased level of gastric mucosubstances (Table : 29, 39) might give a protective layer to the stomach-wall which reduced the incidence of restraint ulcers.

SHAY ULCERS : EFFECT OF AMLAKI (Emblica officinalis Linn.)

As early as 1945, Shay and his group of workers developed a methodology by which ulcers can be induced in stomach of experimental animals.[128] They noted the presence of ulcers in the stomach of rat when the animal was kept in a cage for 16 hours under pylorous ligation. We adopted the same methodology and found severe ulcers in the glandular part of stomach of rats. Some ulcers were large, penetrating associated with haemorrhage. Shay et al. did not study the reason behind this ulceration. We observed that Shay technique did not exert any effect of gastric acidity and peptic activity (Table :20), but decreases the levels of gastric dissolved mucin and gastric mucosal mucose (Table 30, 40).

When studing the role of amlaki (Emblica officinalis Linn.) on Shay ulcers, we found that amlaki-diet could

prevent the incidence of Shay ulcers by about 60%. We gave amlaki (Emblica officinalis Linn.) to the rats orally in the dose of 1 g/kg once in a day for consecutive three days before giving Shay stress. (Table :10)

It was found out that amlaki (Emblica officinalis Linn.) had no effect on the rate of gastric secretion, gastric acidity and peptic activity during Shay ulceration (Table :20)but could increase the levels of total hexose, hexosamine, methyl pentose and sialic acid (Table :30, 40) - the constituent carbohydrates of gastric mucin as well as gastric mucosal mucus. Antiulcerogenic effect of amlaki (Emblica officinalis Linn.) in Shay ulcer can thus be explained in terms of defensive mucosubstances.

Concept of antiulcerogenic property of indigenous plants and fruits was not new. Sanyal and his group of workers observed the antiulcerogenic effect of vegetable banana in restraint ulcers in rat and phenylbutazone induced peptic ulcers in guinea-pig.[28,122] Sinha et al.[140] advocated the use of banana (Musa sapientum), tomato (Lycopersicum esculentum), brinjal (Solenum melongena), etc. in peptic ulcer as these vegetables could decrease the rate of gastric secretion.

Present study also confirms the antiulcerogenic property of amlaki (Emblica officinalis Linn.) in experimental ulcers as we observed :

* Amlaki (Emblica officinalis Linn.) could decrease the incidence and severity of gastric ulcers in ten different experimental ulcer models.

** Antiulcerogenic property of amlaki (Emblica officinalis Linn.) could not be explained by offensive (acid-peptic) factors since amlaki-diet had no effect on rate of gastric secretion, gastric acidity and peptic activity during ulceration.

*** Antiulcerogenic property of amlaki (Emblica officinalis Linn.) could be explained by defen--sive (mucus) factor since amlaki-diet increased the levels of gastric dissolved mucin and gastric mucosal mucus during ulceration. This increased level of gastric mucosubstances might render a 'protective barrier' on the stomach-wall which could resist the toxic effect of ulcerogenic drugs / methods for forming ulcer.

S U M M A R Y

Role of amlaki (Emblica officinalis Linn.) in experimental ulcers was described.

1. Experimental gastric ulcers were induced in albino rats by the drugs like :

   a. Aspirin (100mg/kg, intraperitonially)

   b. Salicylic acid (100 mg/kg, intraperitonially)

   c. Paracetamol (100 mg/kg, intraperitonially)

   d. Indomethacin (25 mg/kg, intraperitonially)

   e. Prednisolone (30 mg/kg, intraperitonially)

   f. Hydrocortisone (50 mg/kg, intraperitonially)

   and by the methods like :

   g. Restraint stress

   h. Shay technique

guinea-pigs by the drug :

   i. Phenylbutazone (100 mg/kg, orally)

mice by the drug :

j. Histamine (33 µg/mouse, intraperitonially)

Drugs were given once in a day for consecutive three days.

2. Glandular part of the stomach of all animals developed massive ulcers by the aforesaid drugs and methods.

3. Sundried amlaki (Emblica officinalis Linn.) powder in a dose of 1 g/kg was given orally to the animals of all ulcer models once in a day for consecutive three days alongwith the ulcerogenic drugs.For 'Restraint' and 'Shay' models amlaki (Emblica officinal Linn.) was given in the same way prior to the application of methods.

4. Amlaki (Emblica officinalis Linn.) was found 'antiulcerogenic' in all the ulcer models studied since it decreased the incidence and severity (50 - 80%) of ulcers induced by ulcerogenic drugs / methods.

5. Gastric juice was collected from the animals and rate of gastric secretion, gastric acidity and peptic activity were determined during ulceration as well as after treatment with amlaki (Emblica officinalis Linn.).

6. Rate of gastric secretion, gastric acidity and peptic activity were not much affected during ulceration and after treatment with amlaki (Emblica officinalis Linn.)

7. Dissolved gastric mucin of the animals was analysed during ulceration and effect of amlaki (Emblica officinalis Linn.) diet on it was studied.

8. Level of dissolved gastric mucin in terms of its constituent carbohydrate components viz. total hexose, hexosamine, methyl pentose and sialic acid was found significantly decreased ($p < .01$ to $p < .001$) during ulceration. Amlaki (Emblica officinalis Linn.) diet, on the other hand, increased significantly ($p < .025$ to $p < .001$) the level of dissolved gastric mucin.

9. Gastric mucosal mucus was collected from the ulcerated stomachs and its amount was determined. Effect of amlaki (Emblica officinalis Linn.) on the said parameter was also studied.

10. Level of gastric mucosal mucus of the animals was found significantly ($p < .01$ to $p < .001$) decreased during ulceration. Amlaki (Emblica officinalis Linn.) diet could increase the level of gastric mucosal mucus at a significance level of $p < .001$.

11. Antiulcerogenic effect of amlaki (Emblica officinalis Linn.) was thus explained not on the basis of offensive factors like acid-pepsin but by defensive parameters like mucosubstances of gastric juice and gastric mucosa.

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