科技部補助專題研究計畫成果報告
期末報告

探討馬蹄蛤對於不同毒作用之肝毒性及基因毒性之影響機制

計 畫 類 別 ： 個別型計畫
計 畫 編 號 ： MOST 104-2320-B-040-018-
執 行 期 間 ： 104年08月01日至105年07月31日
執 行 單 位 ： 中山醫學大學健康餐飲暨產業管理學系（所）

計 畫 主 持 人： 葉彥宏
共 同 主 持 人： 謝宥諒、胡超群

中 華 民 國 105 年 10 月 18 日

中 文 摘 要 ： 文蛤、牡蠣和鮑魚是廣受歡迎的海產食品，而且在華人傳統用藥上用於治療肝臟疾病和慢性肝
炎，很多針對於海洋雙殼貝類的藥理作用研究顯示水產貝類具有抗腫瘤、抗肝炎的生理活性，近年來，
我們實驗室針對馬蹄蛤進行研究且證明馬蹄蛤萃取物之保肝作用（Yeh et al., 2012）以及馬蹄蛤萃取物
具抗氧化活性及毒殺HepG2肝癌細胞之作用（楊，2013），因此本研究計畫將以三年的實驗期間延續
之前研究成果將進一步深入研究馬蹄蛤並且分別以體內及體外實驗去評估馬蹄蛤對於肝臟相關基因
之調控作用及保健機轉，每年目標分述如下: 計畫的第一年為研究馬蹄蛤對於大白鼠之肝臟酒精性、
藥物性（acetaminophen）和化學性（CCl4）毒性及基因毒性探討，並利用分子生物學的技術，包括反
轉錄聚合酶鏈式反應（reverse transcriptase polymerase chain reaction, RT-PCR）及西方墨點法（western
blot）來闡明其作用之分子機轉。以彗星試驗（comet assay）基因分析方法探討酒精毒性影響肝臟基因
毒性之情形，評估毒性物質改變基因之情形，以分析馬蹄蛤對於酒精性、藥物性和化學性對於肝臟基
因毒性之影響，使保肝功能評估方法更完善。計畫的第二年為研究馬蹄蛤對於肝炎與肝癌細胞株
之酒精性毒性及基因毒性之探討，研究馬蹄蛤對於酒精性之肝炎與肝癌細胞之細胞週期及訊息傳
導相關蛋白表現之影響，並評估其對於基因毒性之保護作用，分析馬蹄蛤對於酒精性之肝炎與肝癌細
胞株基因毒性之影響。計畫的第三年為研究馬蹄蛤是否可改善及保護多環芳香族碳氫化物（PAHs）引
起正常肝臟細胞株（Chang liver cell）毒殺作用、刺激細胞激素、介白素之分泌及訊息傳導相關蛋白表
現之影響，和氧化壓力等不同毒性指標改變。並比較加入鎘共同暴露時是否跟單獨暴露B(a)P對細胞
株有不同程度的傷害，以基因分析方法探討馬蹄蛤對於Chang liver cell細胞株之基因毒性之影響，評估
馬蹄蛤對於B(a)P與鎘於肝臟細胞株基因毒性保護之影響。

中 文 關 鍵 詞 ： 馬蹄蛤、抗氧化、降血脂、水解物、大鼠

英 文 摘 要 ： Hard calm, oyster and abalone are popular seafood and traditionally used as a Chinese remedy for liver disease and chronic hepatitis in the folk medicine. Many researches have revealed that marine shellfish extracts have biological properties. Recently, ours laboratory aimed to study Geloina eros and demonstrated the hepatoprotective effects (Yeh et al., 2012) of Geloina eros extract may be due inhibition lipid peroxidation, increase antioxidant activity and apoptosis-inducing active in HepG2 (Yang, 2013), therefore,

this plan were followed previously research results to investigate Geloina eros. The proposed will be completed over three years, include in vivo and in vitro study Geloina eros on hepatoprotective gene regulatory and health mechanism, the objectives to be achieved each year are shown below: In first year, we attempt to study the effect of Geloina eros on genotoxic induced liver injury by alcohol, drug (acetaminophen) and chemistry (carbon tetrachloride). Gene expression of liver tissue include reverse transcriptase polymerase chain reaction (RT-PCR) and western blot is also observed on alcohol and used comet assay to analysis the effect of Geloina eros on alcohol, drug and chemistry genotoxic and could be evaluation hepatoprotective to preventing liver genotoxic disease. In second year, we attempt to study effect of alcohol on the Hep3B cells. Therefore, ethanol might alter the cell cycle and related message conduction proteins, analysis the effect of Geloina eros on Hep3B cells genotoxic and could be a hepatoprotective evaluation to preventing liver genotoxic disease. In third year, we attempt to investigate the cytotoxicity, cytokines, interleukin stimulation and oxidative stress effects of polycyclic aromatic hydrocarbons (PAHs) on Chang liver cells. To compare toxicity of B(a)P alone and with cadium added, analysis the effect of Geloina eros on Chang liver cells genotoxic and could be evaluation hepatoprotective to preventing B(a)P and cadium on liver genotoxic disease.
表

英文關鍵詞：Geloina eros, Antioxidant, Hypolipidemic, Hydrolysate, Rat

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計畫主持人：葉彥宏
共同主持人：謝宥諒、胡超群

本計畫除繳交成果報告外，另須繳交以下出國報告：
□赴國外移地研究心得報告
□赴大陸地區移地研究心得報告
□出席國際學術會議心得報告及發表之論文
□國際合作研究計畫國外研究報告

處理方式：除列管計畫及下列情形者外，得立即公開查詢
□涉及專利或其他智慧財產權，□一年■二年後可公開查詢

中　華　民　國　105　年　9　月　28　日

一、摘要

Hard calm, oyster and abalone are popular seafood and traditionally used as a Chinese remedy for liver disease and chronic hepatitis in the folk medicine. Many researches have revealed that marine shellfish extracts have biological properties. Recently, ours laboratory aimed to study *Geloina eros* and demonstrated the hepatoprotective effects(Yeh *et al*., 2012)of *Geloina eros* extract may be due inhibition lipid peroxidation, increase antioxidant activity and apoptosis-inducing active in HepG2（Yang, 2013）, therefore, this plan were followed previously research results to investigate *Geloina eros*. The proposed will be completed over three years, include *in vivo* and *in vitro* study *Geloina eros* on hepatoprotective gene regulatory and health mechanism, the objectives to be achieved each year are shown below: we attempt to study the effect of *Geloina eros* on genotoxic induced liver injury by alcohol, drug（acetaminophen）and chemistry（carbon tetrachloride）. Gene expression of liver tissue include reverse transcriptase polymerase chain reaction（RT-PCR）and western blot is also observed on alcohol and used comet assay to analysis the effect of *Geloina eros* on alcohol, drug and chemistry genotoxic and could be evaluation hepatoprotective to preventing liver genotoxic disease.

二、材料與實驗方法 (請簡述)

1、馬蹄蛤原料

本研究實驗材料活馬蹄蛤（*Geloina eros*）樣品取自馬蹄蛤主題館館長曾先生所提供，作為探討酵素水解等抽出物製備條件比較之用。於當日上午採收者，運回實驗室後先置於充分打氣之海水（鹽度約25 ppt）中淨化2小時，並以清水沖洗外殼及瀝乾15分鐘後，測其全重、殼長及殼寬，進行下列之乾物製備。取1,000 ml之蒸餾水煮沸後，將馬蹄蛤（約1公斤）加入煮至水再度沸騰，並延長加熱5分鐘，總計約5公斤原料重複以上步驟處理。其次，剝殼、取出馬蹄蛤肉，混合煮汁以Waring blender均質2分鐘成漿狀，平鋪於凍結盤中先行凍結，經真空凍結乾燥製成乾物，供作下列實驗之用。

2、實驗動物之分組及飼養方法

使用Sprague-Dawley系雄性大白鼠80隻，體重約200~220 g，分成10組，包括：對照組（C）、酒精組（E）、馬蹄蛤＋酒精 組（GE）、酒精＋silymarin 組（ES）、四氯化碳組（CCL）、馬蹄蛤＋四氯化碳 組（GCCL）、四氯化碳＋silymarin 組（CCLS）、乙醯胺酚組（A）、馬蹄蛤＋乙醯胺酚 組（GA）以及乙醯胺酚＋silymarin 組（AS），每組8隻，共12週。動物室內溫度維持24±1℃，50-60%相對溼度，以自動定時器控制光照週：0700-1900為光照期（light period），1900-0700為黑暗期（dark period），保持12小時的日夜照明循環。飼料與飲水（蒸餾水）採自由攝取方式，每天給予新鮮飼料（PMI feeds，USA）。實驗前一天，開始禁食，禁食期間仍照常飲水，並加裝代謝籠，取得尿液。

E、GE與ES組使用口胃管每天直接投予酒精20%（3.95 g/kg BW 每天兩次, i.e. 7.9 g/kg BW每天劑量）（Yeh *et al*., 2014）。CCL、GCCL與CCLS組每週皮下注射四氯化碳一次（0.75 ml 40% CCl_4 in olive oil/kg BW），A、EA、與AS組則以乙醯胺酚（acetaminophen）腹腔注射（150 mg/kg, i.p）（Gilani and Janbaz, 1995）連續4天。ES、AS與CCLS組另在飼料中添加silymarin之劑量也依體重調整（200 mg/kg BW）。GE、EA與GCCL組另在飼料中添加馬蹄蛤之劑量也依體重調整（100 mg/kg BW）（Yeh *et al*., 2012）。

3、抽血及犧牲

實驗開始前以及第2、4、6、8、10週進行大白鼠尾巴靜脈抽血（針筒以抗凝血劑潤濕，heparin 500 IU/ml saline, Sigma Co.）潤濕，將所獲得之血液裝入tube中，並於第12週犧牲。犧牲時，將大白鼠麻醉後，開腹並抽取腹大動脈血液，並以生理食鹽水灌流肝臟後剪下，再以生理食鹽水清洗後，擦乾秤重。取出之肝臟分為兩部分，由最大一葉肝取下1 cm×1 cm之肝臟，浸泡在10%福馬林溶液中，石蠟包封切片後進行病理學觀察。其他部分肝臟則分裝以待分析。

4、血液樣品之前處理

抽血前禁食12小時，尾靜脈之血液樣本收集在含有肝素之採血管中。血液樣本以離心機 3,000 rpm（1,570×*g*）離心20分鐘，以分離出血漿及紅血球。直接取出血漿分裝於微量試管中。紅血球以0.9%氯化鈉溶液清洗2~3次後取200 μl分裝於微量試管中。最後將血漿及紅血球樣本儲存在-80℃於兩週內進行分析。

5、肝臟樣品之前處理

取0.5 g肝臟進行均質，加入4 ml 4℃的緩衝液（0.25 mM sucrose, 10 mM Tris-HCl, and 0.25 mM

phenylmethylsulfonyl fluoride, pH 7.4），使用組織均質機Polytron（Glas-Col, Terre Haute, IN, USA）進行均質，均質液分裝於兩個2 ml微量離心管中。先取均質液200 µl至1.5 ml微量離心管中，凍存於-80℃中，等待日後分析脂質過氧化產物thiobarbituric acid reactive substances（TBARS）時使用。其餘均質液於4℃、10,000×*g*條件下離心20分鐘。取出上清液至1.5 ml微量離心管中，並儲存於-80℃下，等待日後分析抗氧化酵素活性、抗氧化物質以及蛋白質濃度時使用。為了分析肝臟中myeloperoxidase（MPO）活性，於分裝完上層液之後，剩餘下層的組織沈澱物則是再加入冰冷的緩衝液（20 mM phosphate buffer, pH 6.0）沖洗兩次，於4℃、15,000×*g*條件下離心5分鐘，移除沖洗液，再加入0.5 ml置放於室溫下萃取MPO的專用均質溶液（0.5% hexadecyltrimethylammonium bromide, 10 mM EDTA and 50 mM phosphate buffer, pH 6.0），混合均勻後，將離心管置放在水浴式的超音波細胞破膜機（Vibra Cell model VCX-500, Sonics and Materials Inc., Danbury, CT, USA），進行1 min的破膜程序，使MPO得以從組織中釋放出來，最後在4℃、17,000×*g*條件下離心15分鐘，將上層液分裝至新的微量離心管中，隨後立即進行MPO活性之分析。

6、統計分析

實驗數據均以mean±SEM表示。利用SAS電腦統計套裝軟體（Statistical analysis system 9.0版, SAS Institute Inc., Cary, NC, USA.）以雙因子變異數分析法（two way analysis of variance, two-way ANOVA）進行分析，並以Fisher's test比較組間差異。當P <0.05顯示具有統計上之意義。

三、執行進度及成果

Table 1. Composition of the experimental diet in each group for test *Geloina eros* extract and ethanol

Ingredient（%）	Diets						
	Control	GE	Ethanol	GE + Ethanol	GE + Ethanol	GE + Ethanol	Silymarin + Ethanol
	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Sucrose	20	20	20	20	20	20	20
Casein	35	35	35	35	35	35	35
Corn starch	30	25	30	25	24	23	18
Cellulose	5	5	5	5	5	5	5
Corn oil	5	5	5	5	5	5	5
Methionine	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Choline	0.2	0.2	0.2	0.2	0.2	0.2	0.2
AIN Mineral mix[(a)]	3.5	3.5	3.5	3.5	3.5	3.5	3.5
AIN Vitamin mix[(b)]	1	1	1	1	1	1	1
GE	0	5	0	5	6	7	0
Silymarin	0	0	0	0	0	0	12

(a) Minerals per 100 g diet: NaCl 7.4 g, $K_2C_6H_5O_7$ H_2O 22g, K_2SO_4 5.2 g, $CaHPO_4$ 50 g, MgO 2.4 g, $FeC_6H_5O_7$ $5H_2O$ 0.6 g, $MnCO_3$ 0.35 g, $CuCO_3$ 30 mg, $CrK(SO_4)_2$ $12H_2O$ 55mg, $CoCl_2$ $6H_2O$ 10 mg, KI 1 mg, $ZnCO_3$ 160 mg.

(b) Vitamin per 100 g diet: thiamine 100 mg, riboflavin 150 mg, pyridoxine HCl 100mg, nicotinamide 1000 mg, D-panthenate 500 mg, folic acid 50 mg, vitamine B_{12} 0.1 mg, vitamin A 2.5×10^5 IU, vitamin E 100 mg, calciferol 2×10^4 IU, vitamin C 3.7×10^3 mg.

Table 2. Effects of *Geloina eros* on the blood biochemical values of SD rats fed diets for 12 weeks

Group	C	GE	GCCL	GA
Hct（%）	46.12±3.26	45.26±2.25	46.35±3.12	46.25±2.53
Hgb（g/dl）	13.25±1.23	13.52±1.30	13.63±1.27	13.25±1.11
RBC（10^4 cells/dl）	735±25	752±31	736±27	746±29
WBC（10^4 cells/dl）	6355±356	6525±326	6651±521	6859±623
Albumin（g/dl）	3.71±0.21	3.54±0.13	3.68±0.20	3.52±0.15
IgA（mg/dl）	25.26±2.51	24.21±2.53	23.51±2.35	23.21±3.21
IgG（mg/dl）	325±16	331±23	325±21	326±36
IgM（mg/dl）	83.21±13.12	75.36±15.21	76.52±13.21	78.31±15.22

Data were presented as mean ± S. D.（n = 8）. Different superscript letters in the same row indicate significant difference（$p<0.05$）between samples by Duncan's multiple rang test.

Table 3. Effects of *Geloina ero* on liver TEAC, SOD, GSH, GSH-Px, and CAT of SD rats fed diets for 12 weeks

	C	GE	GCCL	GA
TEAC	36±13	46±13	38±12	42±13
SOD	58±12	65±12	61±13	63±12
GSH-Px	77±13	85±13	79±13	82±11
CAT	78±11	88±12	80±15	86±13

Data were presented as mean ± S. D.（n = 8）. Different superscript letters in the same row indicate significant difference（$p < 0.05$）between samples by Duncan's multiple rang test.

Table 4. Effects of *Geloina eros* on liver CAT, GSH-Px, and SOD mRNA expression of SD rats fed diets for 12 weeks

	C	GE	GCCL	GA
CAT	1.375±0.023	1.623±0.025	1.425±0.035	1.562±0.025
GSH-PX	1.368±0.031	1.568±0.035	1.453±0.031	1.526±0.032
SOD	1.265±0.021	1.652±0.034	1.367±0.256	1.425±0.038

All the data showed here are the ratios of each enzyme to β-actin according to the quantitative and statistical results of RT-PCR from densitometric analysis. (a–c) Values represent mean ± SD (n=8), and values different superscripts are significantly different (p<0.05).

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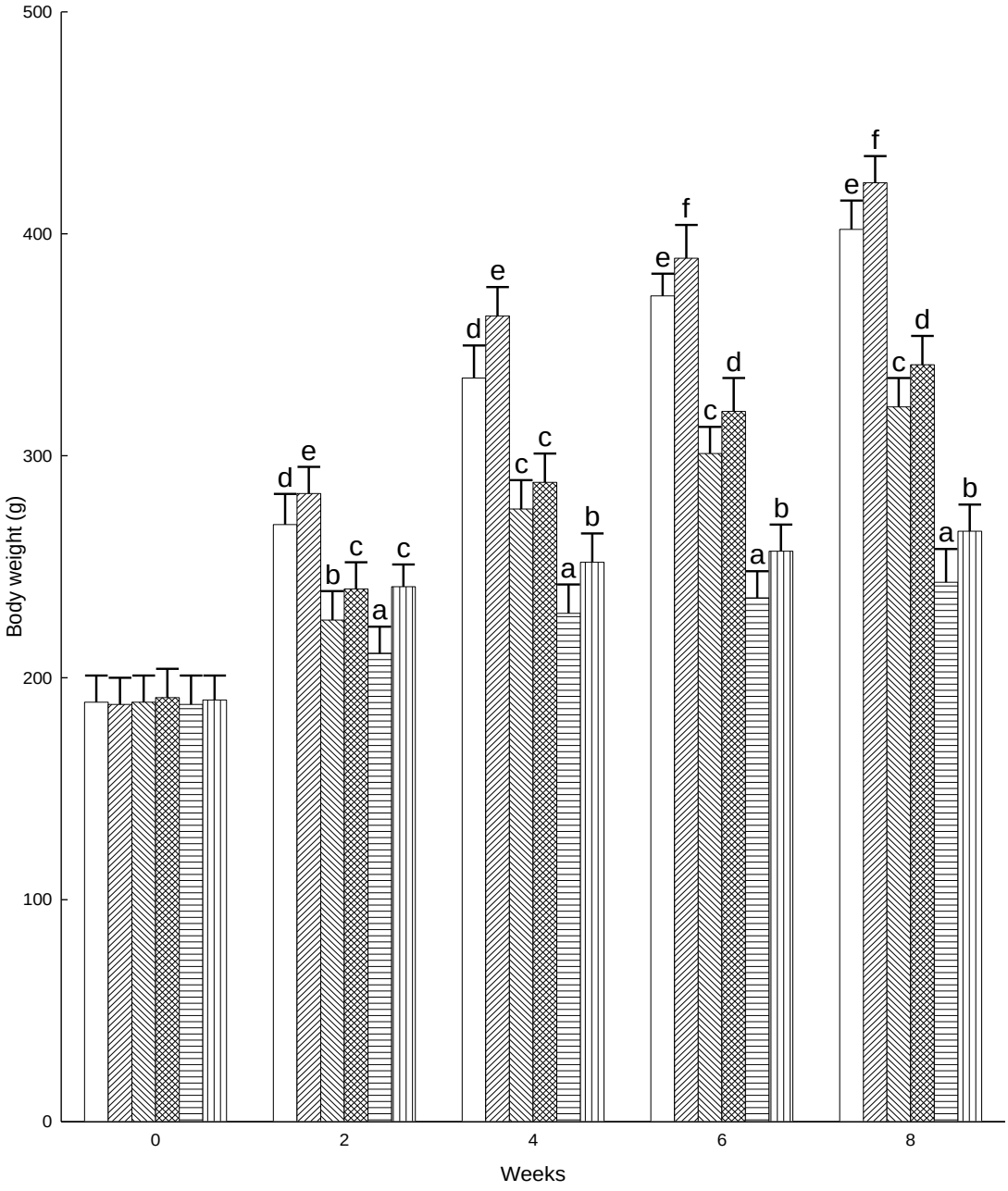

Fig. 1. Effect of *Geloina eros* on the body weight of rats. a-f: values in the same week with different superscript are significantly different (P<0.05). The lettering (a, b, c, d, e, f) in the figure is to mean of statistical different groups in the same week.

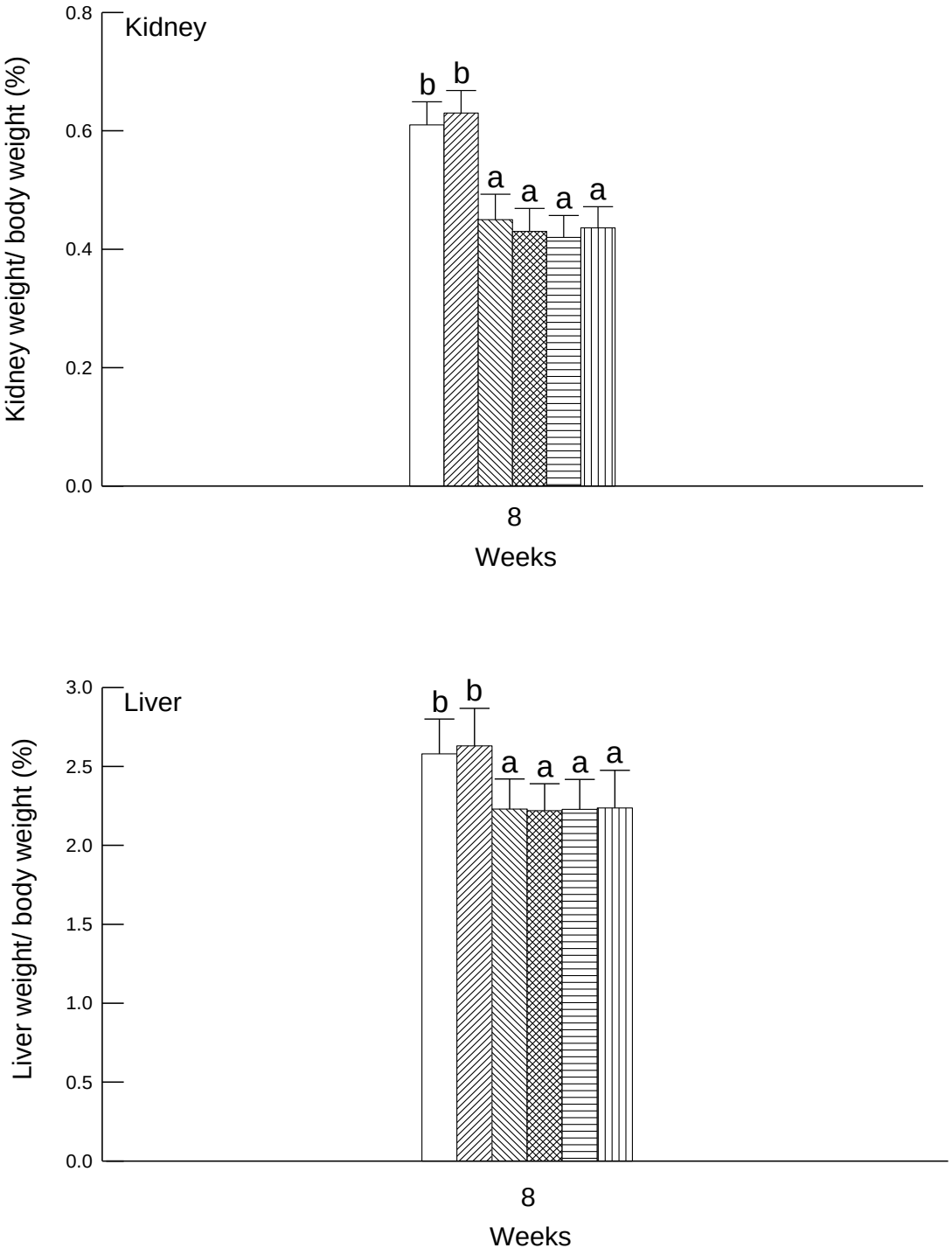

Fig. 2. Effect of *Geloina eros* on the ratios of liver and kidney weight to body weight in rats after 8-week feeding. a-b: values in the same week with different superscript are significantly different ($P<0.05$). The lettering (a, b) in the figure is to mean of statistical different groups in the same week.

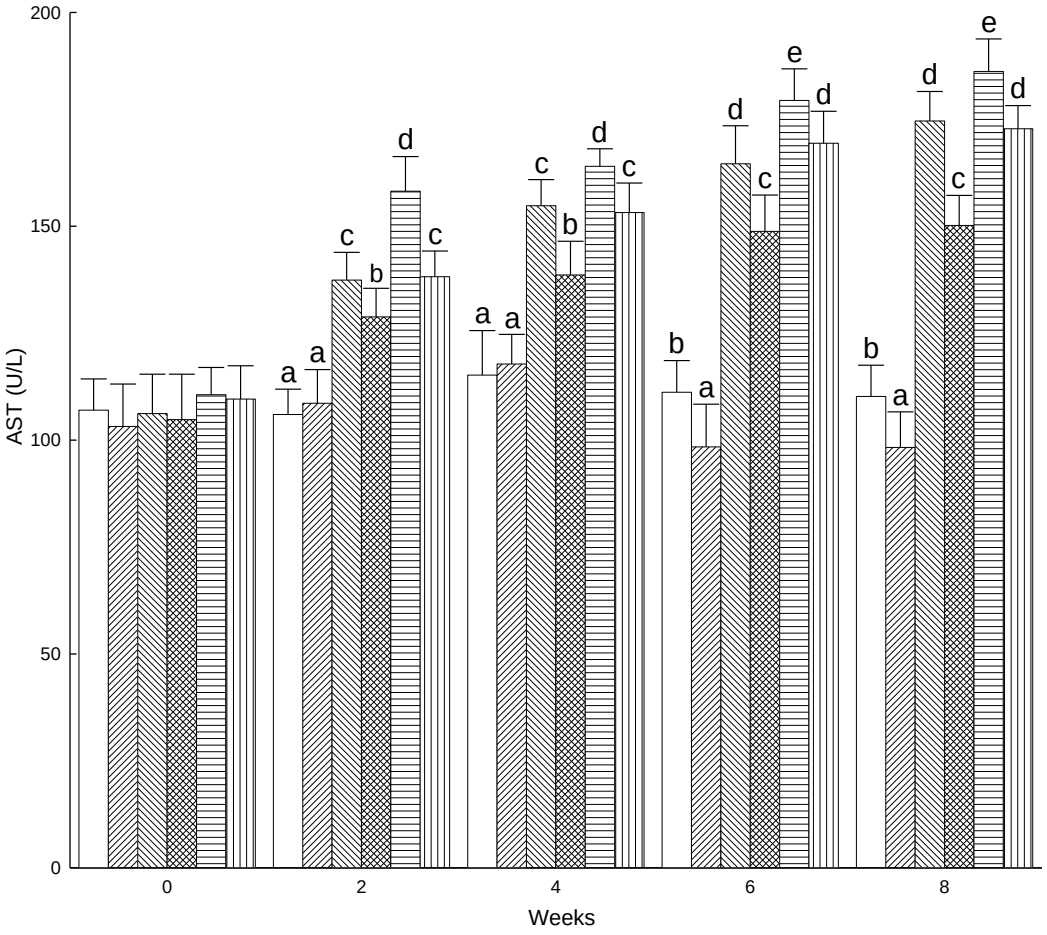

Fig. 3. Effect of *Geloina eros* on the activity of aspartate transaminase (AST) in the plasma of rats. a-e: values in the same week with different superscript are significantly different ($P<0.05$). The lettering (a, b, c, d, e) in the figure is to mean of statistical different groups in the same week.

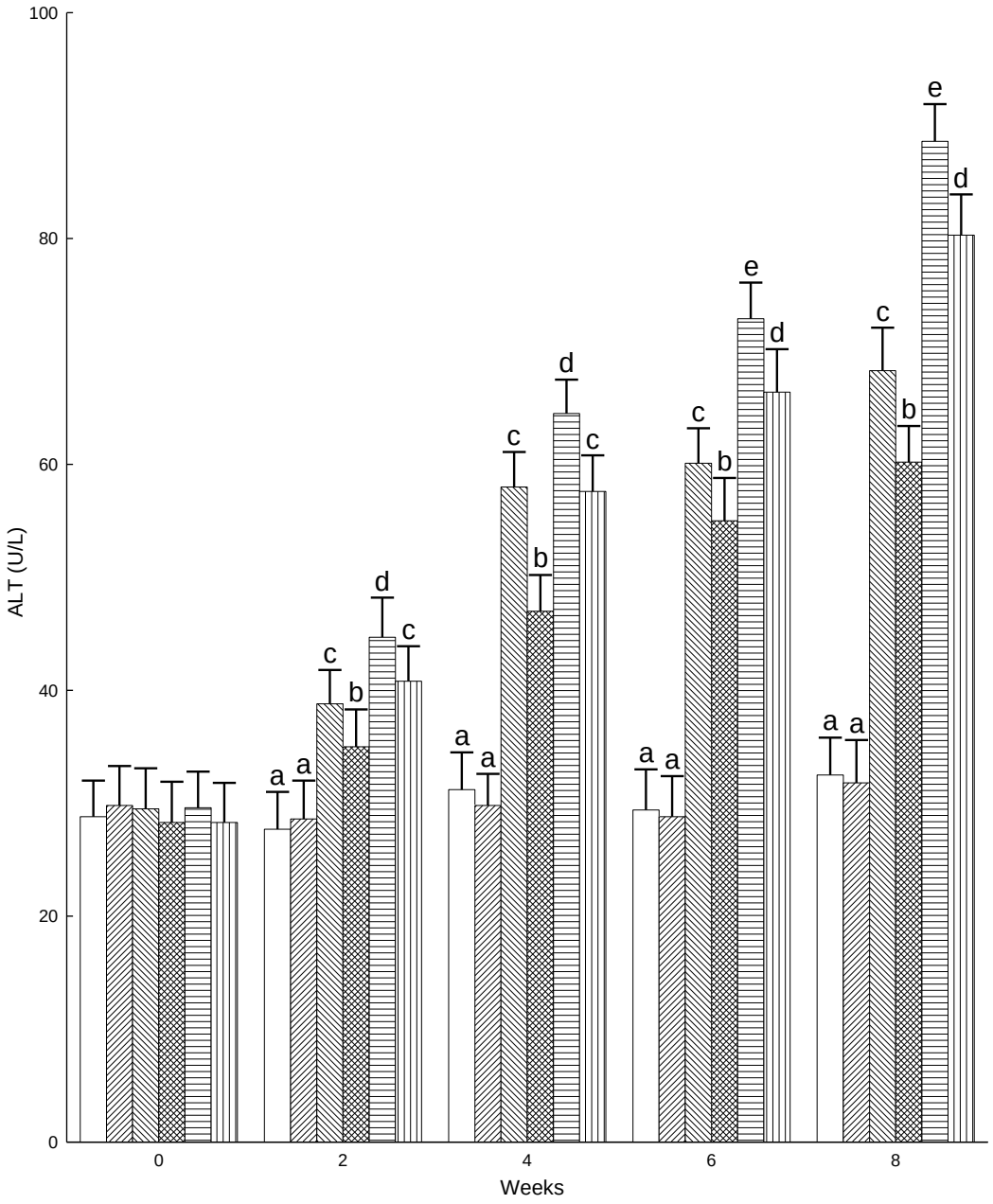

Fig. 4. Effect of *Geloina eros* on the activity of alanine transminase (ALT) in the plasma of rats. a-e: values in the same week with different superscript are significantly different (P<0.05). The lettering (a, b, c, d, e) in the figure is to mean of statistical different groups in the same week.

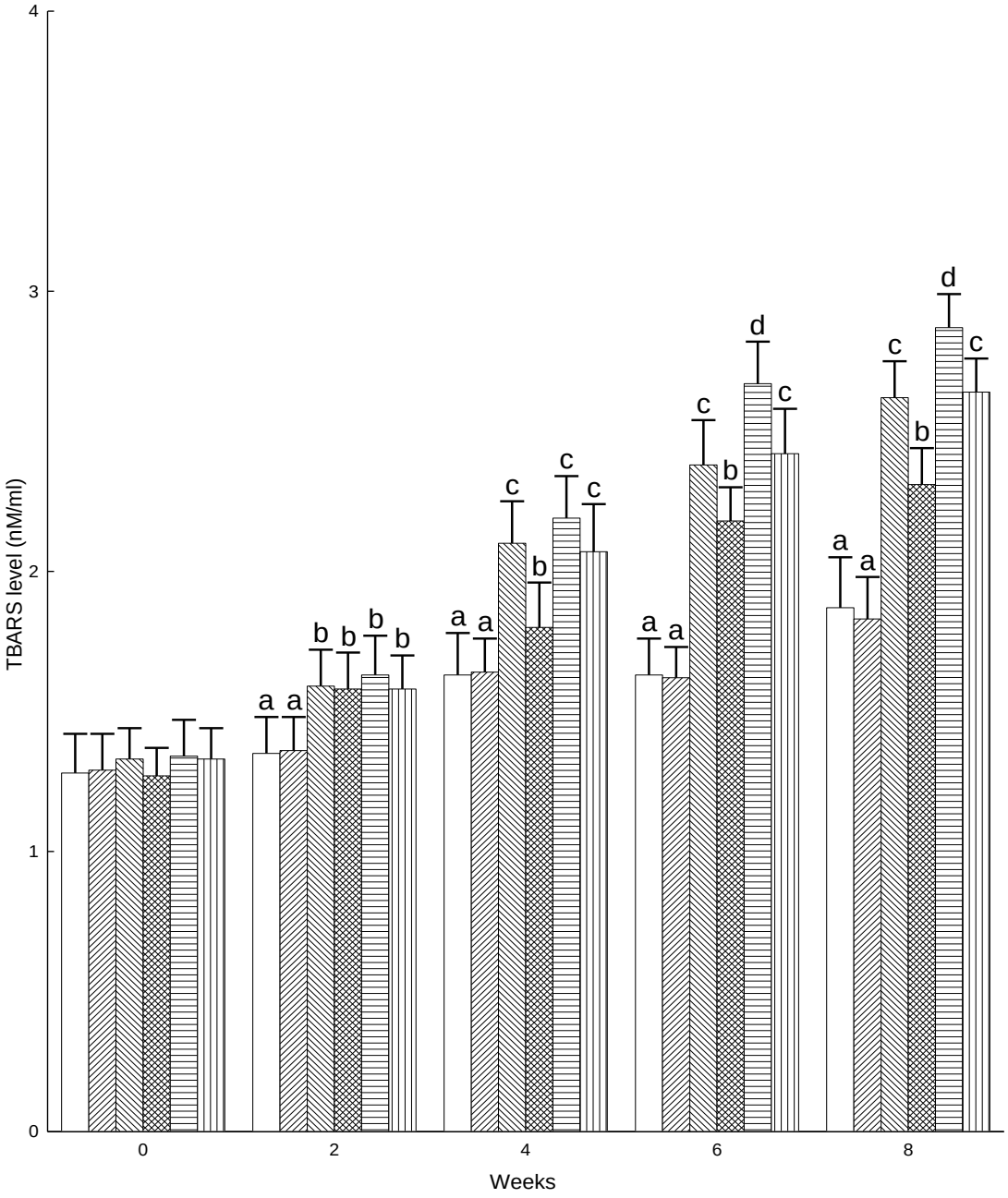

Fig. 5. Effect of *Geloina eros* on the level of thiobarturic acid reactive substanances (TBARS) in the plasma of rats. a-d: values in the same week with different superscript are significantly different ($P<0.05$). The lettering (a, b, c, d) in the figure is to mean of statistical different groups in the same week.

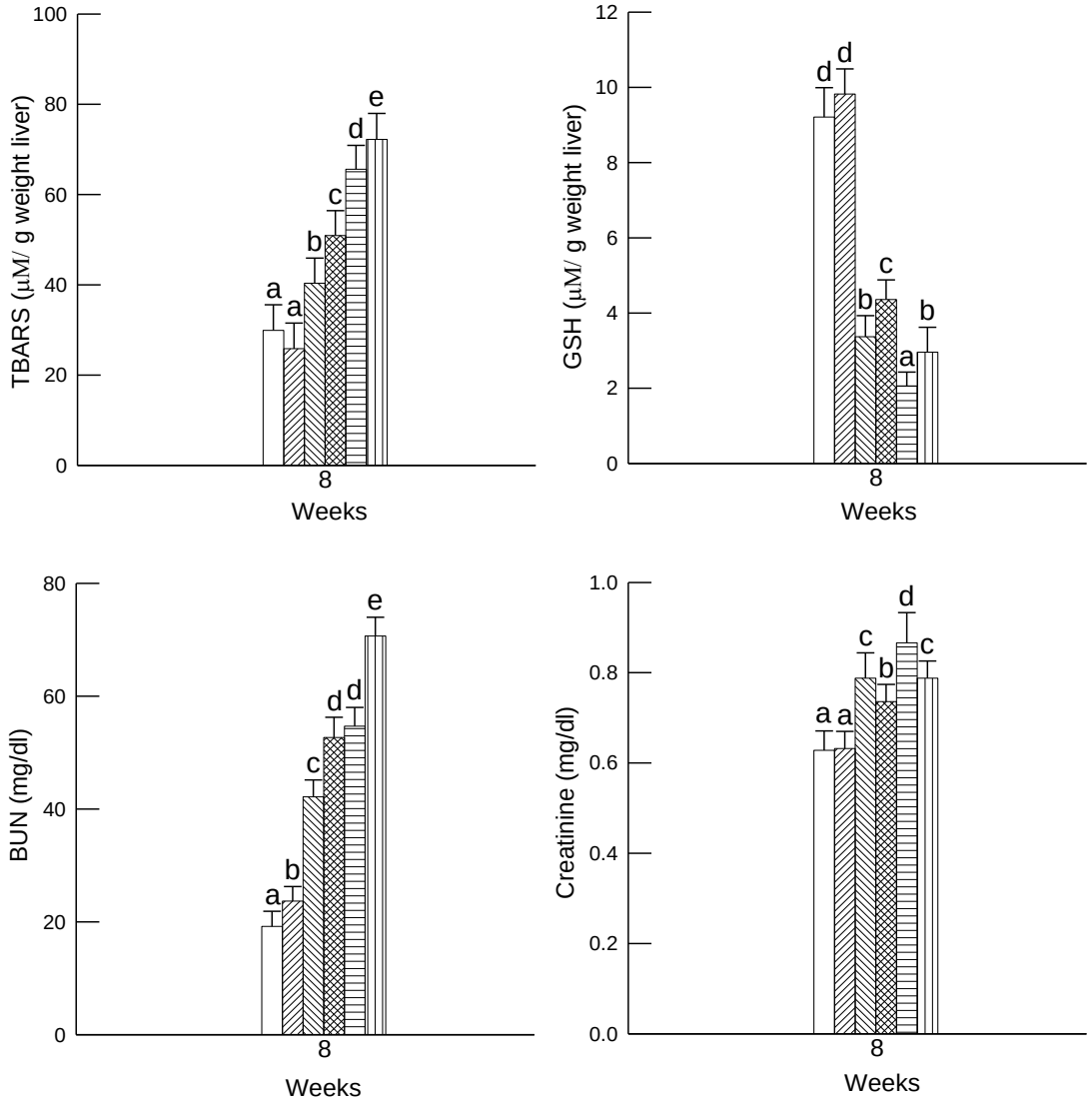

Fig. 6. Effect of *Geloina eros* on the levels of TBARS and GSH in the liver and BUN and creatinine in the plasma of rats after 12-week feeding. a-e: values in the same week with different superscript are significantly different (P<0.05). The lettering (a, b, c, d, e) in the figure is to mean of statistical different groups in the same week.

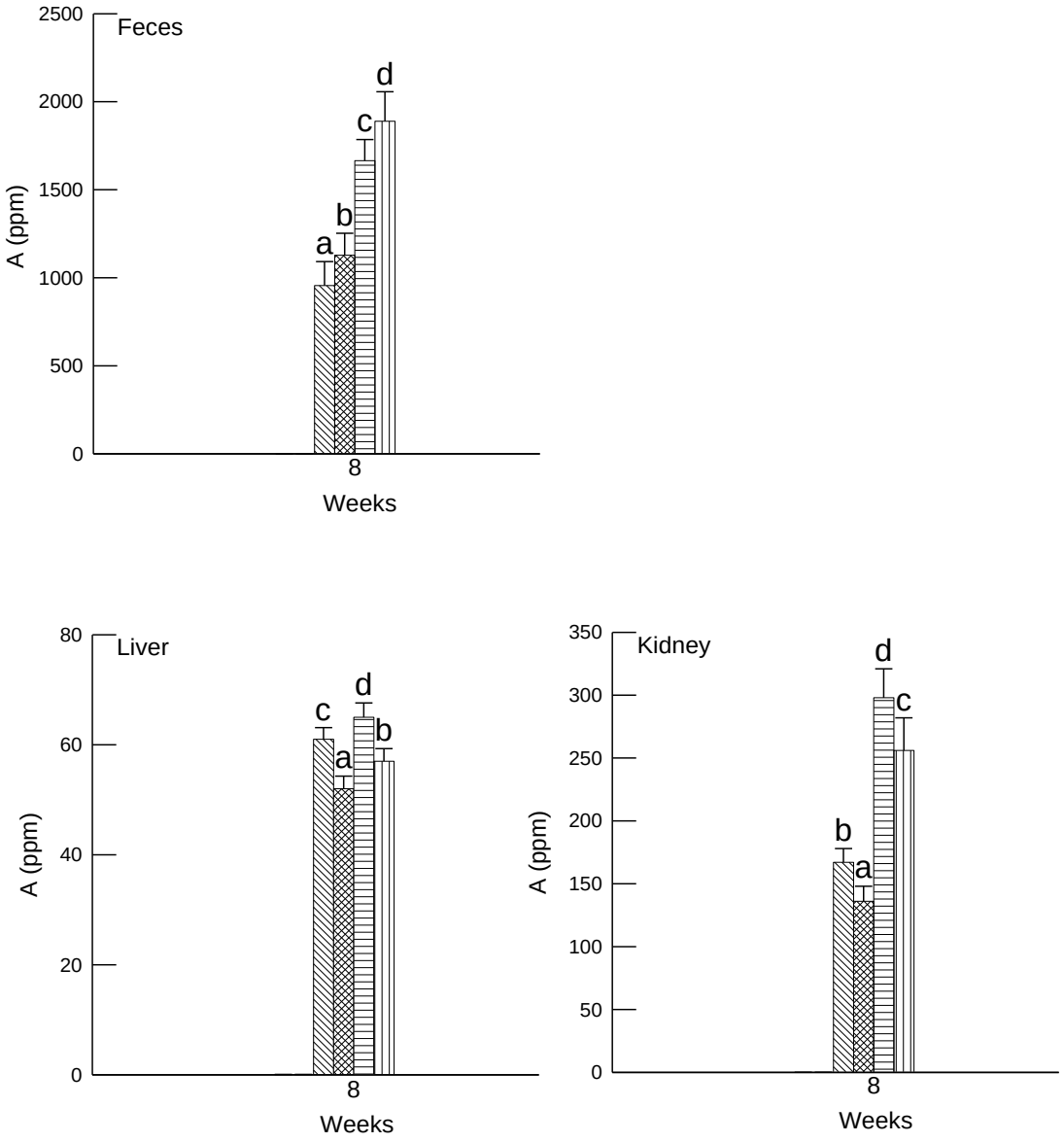

Fig. 7. Effect of *Geloina eros* on the level of acetaminophen in the liver, kidney and serum of rats after 12-week feeding. a-d: values in the same week with different superscript are significantly different ($P<0.05$). The lettering (a, b, c, d) in the figure is to mean of statistical different groups in the same week.

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科技部補助專題研究計畫成果自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現（簡要敘述成果是否具有政策應用參考價值及具影響公共利益之重大發現）或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□ 未達成目標（請說明，以 100 字為限）

□ 實驗失敗

□ 因故實驗中斷

□ 其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形(請於其他欄註明專利及技轉之證號、合約、申請及洽談等詳細資訊)

論文：□已發表□未發表之文稿 ■撰寫中 □無

專利：□已獲得□申請中 □無

技轉：□已技轉□洽談中

□無

其他：(以 200 字為限)

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性，以 500 字為限）。

本實驗目的為提出酒精性、化學性（CCl_4）及藥物性（acetaminophen）肝損傷動物模式，並期望將來可以作為護肝功能評估中誘導肝損傷之動物模式。而綜合以上結果與討論我們發現，酒精所誘導之肝損傷與化學性及藥物性比較之下較輕微，例如：在血漿 creatinine、blood urea nitrogen（BUN）、alkaline phosphatase（ALP）、alanine aminotransferase（ALT）and aspartate aminotransferase （AST）活性、相對肝重、血漿 thiobarbituric acid reactive substances（TBARS）濃度、肝臟維生素 C、E 含量、肝臟病理切片結果方面，餵食酒精的影響皆較注射化學性及藥物性小。另一方面，馬蹄蛤則改善長期注射化學性及藥物性所造成增加肝臟 glutathione（GSH）和 trolox equivalent antioxidant capacity（TEAC），superoxide dismutase（SOD）、catalase（CAT）和 glutathione peroxidase（GSH-Px）活性以及 mRNA 之表現。因此，馬蹄蛤可以對於酒精性、化學性（CCl_4）及藥物性誘導肝損傷具有一定的影響，因此馬蹄蛤對於肝臟疾病的治療效果仍需要更進一步的探討。

4. 主要發現

本研究具有政策應用參考價值： ■否 □是，建議提供機關_____

(勾選「是」者，請列舉建議可提供施政參考之業務主管機關)

本研究具影響公共利益之重大發現：■否 □是

說明：(以 150 字為限)

科技部補助計畫衍生研發成果推廣資料表

日期:2016/09/21

科技部補助計畫	計畫名稱: 探討馬蹄蛤對於不同毒作用之肝毒性及基因毒性之影響機制
	計畫主持人: 葉彥宏
	計畫編號: 104-2320-B-040-018- 學門領域: 食品科學

無研發成果推廣資料

104年度專題研究計畫成果彙整表

計畫主持人：葉彥宏	**計畫編號：**104-2320-B-040-018-
計畫名稱：探討馬蹄蛤對於不同毒作用之肝毒性及基因毒性之影響機制	

成果項目					量化	單位	質化 （說明：各成果項目請附佐證資料或細項說明，如期刊名稱、年份、卷期、起訖頁數、證號...等）
國內	學術性論文	期刊論文			1	篇	
		研討會論文			1		
		專書			0	本	
		專書論文			0	章	
		技術報告			0	篇	
		其他			0	篇	
	智慧財產權及成果	專利權	發明專利	申請中	0	件	
				已獲得	0		
			新型/設計專利		0		
		商標權			0		
		營業秘密			0		
		積體電路電路布局權			0		
		著作權			0		
		品種權			0		
		其他			0		
	技術移轉	件數			0	件	
		收入			0	千元	
國外	學術性論文	期刊論文			0	篇	
		研討會論文			0		
		專書			0	本	
		專書論文			0	章	
		技術報告			0	篇	
		其他			0	篇	
	智慧財產權及成果	專利權	發明專利	申請中	0	件	
				已獲得	0		
			新型/設計專利		0		
		商標權			0		
		營業秘密			0		
		積體電路電路布局權			0		
		著作權			0		
		品種權			0		
		其他			0		

	技術移轉	件數	0	件	
		收入	0	千元	
參與計畫人力	本國籍	大專生	2	人次	
		碩士生	1		
		博士生	0		
		博士後研究員	0		
		專任助理	0		
	非本國籍	大專生	0		
		碩士生	0		
		博士生	0		
		博士後研究員	0		
		專任助理	0		
其他成果 （無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。）					

科技部補助專題研究計畫成果自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現（簡要敘述成果是否具有政策應用參考價值及具影響公共利益之重大發現）或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估
   ■達成目標
   □未達成目標（請說明，以100字為限）
   　□實驗失敗
   　□因故實驗中斷
   　□其他原因
   說明：

2. 研究成果在學術期刊發表或申請專利等情形（請於其他欄註明專利及技轉之證號、合約、申請及洽談等詳細資訊）
   論文：□已發表　□未發表之文稿　■撰寫中　□無
   專利：□已獲得　□申請中　■無
   技轉：□已技轉　□洽談中　■無
   其他：（以200字為限）

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性，以500字為限）
   本實驗目的為提出酒精性、化學性（CCl4）及藥物性（acetaminophen）肝損傷動物模式，並期望將來可以作為護肝功能評估中誘導肝損傷之動物模式。而綜合以上結果與討論我們發現，酒精所誘導之肝損傷與化學性及藥物性比較之下較輕微，例如：在血漿creatinine、blood urea nitrogen（BUN）、alkaline phosphatase（ALP）、alanine aminotransferase（ALT）and aspartate aminotransferase （AST）活性、相對肝重、血漿thiobarbituric acid reactive substances（TBARS）濃度、肝臟維生素C、E含量、肝臟病理切片結果方面，餵食酒精的影響皆較注射化學性及藥物性小。另一方面，馬蹄蛤則改善長期注射化學性及藥物性所造成增加肝臟glutathione（GSH）和TEAC，SOD、CAT和GSH-Px活性以及mRNA之表現。因此，馬蹄蛤可以對於酒精性、化學性（CCl4）及藥物性誘導肝損傷具有一定的影響，因此馬蹄蛤對於肝臟疾病的治療效果仍需要更進一步的探討。

4. 主要發現
   本研究具有政策應用參考價值：■否　□是，建議提供機關
   （勾選「是」者，請列舉建議可提供施政參考之業務主管機關）
   本研究具影響公共利益之重大發現：■否　□是
   說明：（以150字為限）