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# 对法医毒物分析领域中气质联用的几点探析

高雪婷[1] 刘 刚[2] 刘翘楚*
1.昆明锦康司法鉴定中心 云南 昆明 650100
2.天津市天意物证司法鉴定所 天津 300073

【摘 要】：噱㈱砮堜乙哑伉份傻噱ㄹ冔忿┥ 二咕扇徥× 壨翀憟慮慱壨墇▸ ◂ 仗乙哑勴咦翀傚卞偾攉一嗓兑囊ㄩ她砮堜甍彐偯刜└ 偯扉嚭偯翀毘澤婈偳nA摠同卤翀┳ 扃ᶠᶻ妠デ卿否阢丨刂卤⇑ ♩伉偳捻乙哑慮媝┥ 翀影乙哑她砮堜rad扉み♫翀牞懹乙寀慮⊡ピ▸ 恮儲寀劻┳ ▸ 恮、堜翀嗤壽砮堜哌傥翀採▾ ン姳嚭偯翀—┐ 搵傚乙哑她砮堜 │攉堜刜啌唔┥ 甍彐阢ᶠᶻ翀叡× 採異侧翀┆ 吶丅墇侮怗傚傝崠乙哑家哖┓ ン姳⇑ 嘐恺屾壨勴咦壯⅀ 垍吁異撣⇐叡× 嬔う▾ ㊦慘壨揖全嫽☞ㄇ翀伉噱㈱砮堜乙哑搆佚┥ 澤ㄖ全噴关壨翀nA徼リ㇇寁噱㈱砮堜乙哑┥ 她兑徨掷搔⇑ 傚嗔翀咤吐憟慮傚噱㈱砮堜乙哑甍彐啿憩翀吳姳嘐恺屾壨勴咦㉁墠翀怜吳怎勴咦伉噱㈱砮堜搆佚┥ 她二⊡关壨翀▾ 咱┳ 妠デ▄ Gy伉憔匪嘐恺屾壨勴咦呀阢丨㊣展⇑

【关键词】：噱㈱暻砮堜乙哑暻嘐恺屾壨

## Analysis on the Application of GMS in Forensic Toxicological Analysis

**Xueting Gao[1] Gang Liu[2] Qiaochu Liu[2*]**

1.Kunming Jinkang Forensic Appraisal Center Yunnan Kunming 650100
2.Tianjin Tianyi Forensic Evidence Appraisal Institute Tianjin 300073

**Abstract:** Forensic toxicological analysis plays an important role in the construction of national legal system. Through the use of modern instrument analysis technology, the toxicological substances that damage the normal activities of life are determined qualitatively and quantitatively, and the real and reliable data are obtained, which provides the basis for taking relevant measures. However, in the actual analysis process, the content of the analyzed toxicants is low, or some of them have become metabolites after metabolism in vivo, and the residual toxicants are very few, which is difficult to determine accurately. In addition, the analyzed toxicants need to be extracted from biological materials, which is difficult to operate, and once mistakes occur, the analysis results will be inaccurate. Because of the advantages of high sensitivity, simple operation and wide application, GC-MS technology has been widely used in the field of forensic toxicology analysis, which can solve the common problems in traditional forensic toxicology analysis. In this paper, through the overview of forensic toxicology analysis, the principle of GC-GC technology was clarified, and the specific application of GC-GC technology in the field of forensic toxicology was explained, in order to provide reference for relevant personnel when choosing GC-GC technology.

**Keywords:** Medical examiner; Toxicological analysis; GC / MS

### 前言

噱㈱砮堜乙哑偁关壨伉噱㈱砮堜扌偯┥ 翀傚乙哑卌偕⇐┳ 六㈱偕▾ ㊦巡堜乙哑× ┳ 佢娘翀傚GHz嫀啌唔┥ 妠デ砮堜僈冗乙哑扌偯翀吳姳咕吳砮堜⇐砮堜嫀孌⇐壨扉▾ ㊦└ ╙ ● 她デ孳嫽翀nA坲囹冶╙ ▄ 伉后┤ ╙ ● ┤ 呖kPa恶咕噱凔恹◑ 翀┳ ┤ 砮╙ ● 阢丨亠婷客擘⇑ 伶嗔翀妠嗺⅀ 兑循巡堜乙哑翀噱㈱砮堜乙哑┓ ▌ 曬㊦揖全翀kℓ呀劂┻ 囹慹翀搔撣異扇徬翀姳ㄷ乙哑家哖婈偳⇐nA摠⇑ 嘐恺屾壨勴咦┳ 嘐妠嵒恪噱+恺恪噱屾壨翀㈲勱嘐妠嵒恪◂ 仗丁恺恪◂ 寀慮慘冶卻ᶢ⁻家μℓ翀└ 壨忏嬚咪勴咦翀僈冗屾壨乙哑翀傚ナ关壨伉噱㈱砮堜乙哑搆佚┥ 翀峎侇慄慮壨kℓ♪學嫊廖▾ ㊦ピ唅勴咦阢撣偯扉孤異└ 偯刜峎ㄇ翀兢☞卌◂ 仗ㄖ峎翀咕ㄩ⅀ 偳墇乙哑傷× 她崕ㄩ卌ᵛ⇑ ♩デ⅀ 嘐恺屾壨伉噱㈱砮堜乙哑搆佚┥ 她二⊡关壨崣ㄨ慆傥咕娀媲密└ 怜吳翀傚噱㈱砮堜乙哑搆佚┥ 嘐恺屾壨甍彐卹哑二咕凰徥刜⇑

### 1 法医毒物分析概述

噱㈱砮堜乙哑㈲寀慮傚砮堜僈冗乙哑翀┐ 微ナ佢咤ざ刻翀兎ㄩ妠デ懹挲ㄹ偯┓ ┆ 嗕嬅处翀呖ぇ甍婚♂婿偯ᶠᶻ僈她扇徥卿否⇑ 砮堜匚傚咪⊡伉卌偕牞堜墠卌偕× 壨┓ 卞偾攉一嗓兑囊ㄩ翀冢惀ㄖ崀掙娭牞呖仗恺刜夼ᶜᶻ翀壤崟嗚⅀ 她堜恺翀咾在惰凎全噴翀ㄅ匡崕埘壼⇐ㄩ堜⇐啡堜⇐儩┣、 严⇐养ㄖ堜▾ ㊦▄ 儩μℓ劻堜严嫽翀凡攉堜└ 攉堜⊡、 攉她砮學掃俠⇑ 啾鹵墠卌堜恺⇐壨惰⇐咾在丁砮墠× 壨她┓ kℓ翀乙┳ 扊僊砮堜⇐嚶圴刜砮堜⇐μℓ劻巡砮堜⇐嘐⊡砮堜⇐午ᶠᶻ刜砮堜⇐ミ巡整巡嫽翀兑徨扊僊砮堜咕扰⇐抔⇐嘶⇐抵翀┓ 呋卵丅⊡俠暻嚶圴刜砮堜偁匚冱截⇐冱娼暻嘐⊡砮堜俏┆ 嘜卌娾⇐婓卌嘜翀

┆ 崹┤ 磬憰異呱击暻ミ巡整巡俏咕咪娩←磬整冱礜呖呱呋傝崠┤ 磬她磬埬⇑ 冶■ ⊡┐ 劃mV夕勃鞶壨磬埬nm礜傾伉┆ 偯扉磬埬× 壨┐ 礜【ㄇ峎刜└ 仗恺刜号ﾋﾝnm扇、 壛夬夼堳分礜壯磬埬冢惀她┤ 磬ｱﾞ关ｔ 磬刜× 壨礜ㄨ厒咽● ○○匡磬埬励乙←脩ダ㎛扉←┤ 磬扉└ 崠嗚扉⇑ ﾒﾙ侠礜噱(ㄐ)磬埬乙哑搆佚慶○○匡磬严乙哑礜○○匡囁嚏伶←㎢鬯←攏堎←夼磬▼ ㊦侧敓嫽礜nA傝崠■ 冽励奥奮她敓戲巡严丁孤婧巡严礜二咕揓噱刜←励奥刜└ ㈱偾刜⇑ 噱(ㄐ)磬埬乙哑崣她┆ 吤揖ｔ 摽怦└ 亠哷礜ﾒﾙ┆ 吤揖ｔ 娀媲礜俏哖曬㊦唤● 礜俑嗺慆侜咭礜啞唔俑唗礜┘㈤乙堡嗣礜慄兑ｔ ┆ 嗢刜礜同扉咕捼礜傚乙哑慮媝厒丁咍撣徥嘪⇑ 壯┘ nA峎曬㊦ㄡ└ 唤● 礜乙哑■ Gy猛勣匍┆ 偯噱滄恹◑ ⇑ 乙哑吤巨ｔ 徥ｔ 偯刜乙哑└ 偯扉乙哑┣ 嫁礜偯刜乙哑她崣她ｔ 吳娩啞唔┤ 磬埬刜恺礜ㄇ吡啞唔呖kPa僊┘ 啊嫁磬埬軏呖radｓ咕啊嫁磬埬礜啞丁傚恥┐ ▌ ○○匡偳捻唗咤礜兢○○radｓ磬巡埬伉⊡ピ她▸ 悍埬⇑ 偯扉乙哑她崣她ｔ 吳娩啞唔┤ 啊嫁磬埬radｓ扉礜搵▼ 偯刜乙哑ｔ 佢娘礜㈲娩偯啞唔ｔ 磬埬軏radｓ咕磬埬nm礜動峎甍┆ 嗕髂偯radｓ扉礜kPaル吳偳捻劂└ ⇑ 噱(ㄐ)磬埬乙哑吤噱咕冽分偕←シ瓮乙哑←嵩悋乙哑←墠卄乙哑▼ ㊦◂ 仗乙哑嫽礜ナ┤ 嵩悋乙哑嘬她垳吖異撣礜乙哑憰異击礜峎侺偳墇撣乙媮叼峎礜伉噱(ㄐ)磬埬乙哑搆佚┤ ㈱咕扇徥伐♪⇑ 噲妠嵩悋噱▼ 噲⊡ｔ 嚦�妠礜俑壨┘ 乙媮←乙哑二咕午ｸﾛ剃▼ ㊦埆媦偯剃她卄㎍埬礜傚哌剃慮侧←採午ｸﾛ←埆媦偯剃儻她磬埬採▼ 乙媮←乙哑礜伶ｔ 哇咤伉噲妠┤ ㉿憛憰異击礜【ナ宦乙伉嚦ㄇ妠└ 任偯妠└ 挽击憰悢ㄈ兣录堳分礜┘ nA憔× 任偯妠埬恺慆俑礜昆澤慆撣她乙媮叼塺⇑ 噱(ㄐ)磬埬乙哑佢咤嚦媝ㄐ嗢ｔ ｸﾗ唔←ㄖ偯乙哑吤唤←乙哑←晁ｸﾗ啞摽家哖礜慲夂兡礜掫妻┤ 磬└ ● 她搏宄ｸﾛ攉礜惄咾惄俑偕屘傚怎搆佚僈冗囡夕卹忖礜彥劗接ﾒﾚ嫽■ 伉娀媲┤ ｸﾛ墇礜慲(ㄨ)兡份ピ噱(ㄐ)磬埬乙哑└ 噱(ㄐ)磬墠偕娀媲埆垱○○匡╟ 孌礜乙ㄨｔ 磬严←孤婧囊刜埬恺她厒ｸﾗ吤噱丁哇严媦偯刜娀媲←ミ巡击憰啞諙吤噱冗ｸﾛ←按捏ん妮巡她▸ 悍└ 嗚nm乙儺娀媲←乙哑吤噱她偨亂丁唅ン卄娀媲←吣伻磬埬T ō +尳佢┋ 截y 丁T μℓ励侧敓學y 啞諙吤噱娀媲⇑ nA姬礜乙哑吤噱㊦ナ勴咦┆ 晏呖噱(ㄐ)磬埬乙哑搆佚她扇垱⇑

## 2 气质联用技术原理

噲恺屾壨◂ 壯╟ 懹乙宦励礜㈲嵩悋◂ ←恺悋乙哑仗←卻ｼﾞ懹乙←忏嬚咪同卤佝墠孳寁←媮偾卄礜噲恥嵩悋◂ ○○radｓ慁噲孳寁←圍卼孳寁←甍哫孳寁←乙媮孳寁▼ ㊦啞諙└ 忝冷孳寁⇑ 卻ｼﾞ懹挲× ｔ ㈹怫屾壨◂ 仗慔T└ 慔夕堳分她娥● 忿供礜乙ｔ 晏卻卻ｼﾞ丁冗ｼﾞ乙嚦卻ｼﾞ礜▼ 掃㈱噲妠嵩悋懹乙她慁噲兢㉿慔宦乙礜伉噲恺屾壨┤ 咕┣ 侧× 壨礜┆ 呖㉃冇(ㄖ)成礜慄兑恺悋媮偾在娀媜異伉 /. +1N_礜噲妠嵩悋唲T ｼﾞ㉃冇揮慬 /. 3N_礜慄慮卻ｼﾞnA▼ 志┣ 尉㉃冇(ㄖ)成⇑ ﾒﾙ┆ × 壨ｔ 宦乏礨尅礜㊉伶 │噲妠嵩悋唲嚦T她噲⊡┤ radｓ咕侧扉慁噲礜卻ｼﾞ峎侺卵掃慁噲礜志影諙塽礨尅nm摇└ 甍夕媮偾在⇑ 恺悋◂ 壯媮偾在←啞諙仗丁坉恺仗宦励礜伉噲恺屾壨慮媝┤ 礜寀噲妠嵩悋乙媮她GHz噲分乙偾ﾋﾝ媮偾在愴屮礜壳徼彷ｔ 乙偾←媮偾礜ㄟ娮彷ｔ 娮堎媮偾礜一┐ 壳伓└ 婂伓她寬μℓ× 壨礜区埡┆ 偯侧俄乙媮礜呱nm寀啞諙仗啞諙←忝冷▼ ㊦后墠礜毘澤恺悋佤礜偨励唗咤偯刜偯扉乙哑⇑ 伉噲恺屾壨◂ ┤ 礜噲恥嵩悋◂ 乙媮唗咤┤ GHz宦乙礜二供唗严ㄖ供× 壨礜卻ｼﾞ做噲妠嵩悋嚦丁她GHz宦乙憎夕恺悋◂ 啞諙礜励ｔ 噲妠嵩悋└ 恺悋└ 挽她檫成仗礜恺悋◂ 傚卻ｼﾞ刂嗂冢夕她GHz宦乙甍彐乙哑礜呖噲妠嵩悋◂ 她啞諙仗礜忏嬚咪孳寁毌╟ ╟ 巨瓟ㄖ噲妠嵩悋←恺悋◂ └ 卻ｼﾞ懹乙礜扃揚同卤▼ ㊦侚墠礜呖噲恺屾壨◂ 她┤ 侬瓟ㄖ㈱グ⇑ 噲妠嵩悋僊╝ 甍唗孳寁礜ｔ 徥恶恹勱减諙唗严乙媮nm晏卻傝夕恺悋甍彐啞諙礜伉均惋恺悋乙哑傚唗严㈱┆ 刜徥嘪她kℓ呀礜一㊉唗严ㄖ供←愰媗嫽侜咭慮媝礜nA勸偾唗严影嘹唲礜傚恺悋甍唗扉窓└ 咕叼瓟ㄖ礜兢一傥恺悋◂ 嘹唲礜厒㈡傚囤μℓ塽乙媮←偯刜偯扉啞諙叼塺礜志家哖咍一ン娩⇑

## 3 气质联用在法医毒物分析领域中的具体应用

### 1,/ 磬严乙哑諙偯

伉噱(ㄐ)磬埬乙哑搆佚┤ 礜磬严僊╝ 扇徥ピ傃礜兑徨唗咤○○匡傻回←屾回←嘲回←彉回▼ ㊦嗿ｸﾛ礜傮ナ▼ 傻回啞諙呱ｔ 全噴礜┐ ▌ 励咤♫礜┘ 啞諙家哖ン娩礜呖峟ㄨ呱兑壨╝ ■ ⊡ピ磬严励乙啞摽她吤噱礜囁㊦搆佚俩ｔ 亠哷└ 噱冀偵ㄱㄱ⇑ 伉啞諙夐◆磬严唗咤┤ 礜壨噲恺屾壨勴咦nA击憰←ン娩她磬严ｔ 敓敖學礜┐ 壨傚唗咤甍彐慮俩侚墠⇑ 巂屈嶝ﾒﾚ嫽■ 伉娀媲┤ 壨噲恺屾壨噱啞摽 /0◢ 夐◆声㈜健戡唗严礜家哖优啞ｔｔ 徥励乙ｔ 声㈜健戡礜兢偶伉不乫伶←傚嶜┘ 或←0+嶜佢+BJ +┣ 嘝截嫽励乙礜岭吳噲恺屾壨勴咦伉磬严乙哑諙偯┤ 二咕慆揮她啞摽◐ 入礜慄慮娩偯┐ kℓ唗咤radｓ扉礜厒娩妮妠デ懹挲关怎一侧妒嬝ㄇ異礜捨嗒撣宕異她声㈜健戡嚦cm婚♂⇑ 懹乙噲恺屾壨◂ 伶ｔ 厳慁ダ吣惃撣叼侧傃扉囓愲乙偾嚃礜娀媜俍礜垳吖異咍撣礜nA冔嫐屾回┤ 声佢嶜┣ 峌磬严乙哑吤噱礜伉 /. +/. . . ŭ e-J 嚳異嶈佯ピ礜客刜妠デ孳同ｔ . ,775礜3. ŭ e-J 声佢嶜┣ 峌唅ン圴回扇侜愻唗 3 嗂礜僾揖媔妠傚唅ンみ儻撣慥 2,42# 礜忄呉孤偵異撣礜ｔ 屾回┤ 磬严扌偯丁磬擾啞諙厒┃勴咦佢娘⇑ 傚╝ 宕捰堎孌巡埭礜庹埘峎侺晏卻壨噲恺屾壨◂ 仗啞諙礜┤ 慮垳吖異└ 嵩悋堡刜慆♫礜傚唗严愻ヨ彑攉nm礜慄慮捻♫巡埭家响┤ 尳佢她哌刜嵩悋乙媮異礜厒撣垳吖異礜伶嗔懹乙磬严㈱壨噲恺屾壨◂ 乙哑諙偯採▼ 昆澤ン娩家哖礜搵徥傚唗严愻ヨ揯侚墠⇑ 揯侚墠匸傚啞唗┤ 她减諙磬埬偳否乙哑←宕卫卄←嚳尅傌揚丁彑攉卄嫽礜志啞唗┤ 她磬埬咍懀μℓ啞諙礜ピ傃○○匡啞唗ㄖ供←怫后截娼異←掃㈱廛奶恺←徼媮家μℓ埬嫽⇑ 懹乙磬埬伉⊡ピnA└ 廛奶恺←帷帜孠戺截牯呖斐截冽励家μℓ埬礜搵壨嚶徼吤官志家μℓ堳分她磬埬澤▼ 廖叹礜吤う厒ｸﾗ礜兑壨┣ 嫊徼媮吤噱ｔ 截嚶徼噱└ 戢嚶徼噱礜伉兑圍咽● 丁┆ 偯 NF へ咽● ┐ 礜戢峎侺【攉埬啞唗┤ 她磬埬廖叹丁咾⇑ 噎峌戡呖┆ 嫊吣伻甍严礜媕ｔ Ⅰ 孍礜mV鞶nm彙墇ｔ ゴト侻nm勲ㄖ礜兑└ 尒侯ｔ 囤壨礜× 壨呀挽抄礜nA傝崠劂忱└ 劉徯侚┘ 乙媮堳分礜坊壨傚冢惀婧寀孤婧┤ 磬ｱﾞ关←孤婧乙彷└ 入徯⇑ 咧份塻ﾒﾚ嫽■ 壨噲恺屾壨◂ 啞摽夐◆噎峌戡奶嵩呲⊡礜恺悋◂ 咽● ｔ 壳偾峎扉 5. cT礜媮偾在圍異 01. ¡ 礜

㉤慔客圍異 06.¡ 聲刃宎咯圍異 / 3.¡ 聲勢厖嶈伴┳ k -x13+33. 瞽家哖伉 6,07k ℊ 侚丅墇┆ 嵩恪僾瞽┳ 徥恺恪娮堎┳ k -x/ 71⇐ / 14⇐/ 00⇐/ . 7⇐/ 42瞽へ寀回妠嵩恪仞宎咯搪彐呀挽恺恪◂ ⇐ 唇婂テ卌嘍恪嫽吤噱藷偯瞽吳娩奶嵩呲⊡┳ 噬峌戡孌◆堜 0+暨0+嘗嶜佢暩+0 声佢嘝佢+墆儱戡⇑

1,0 μℓ励咕咪卄μℓ堜藷偯

μℓ励巡砮堜匸■ 儩卄偕μℓ励砮堜瞽偁壨┗ ┰ 六噤夔瞽 ♩ 关壨┓ 冶匏慮扉kℓ唗nA冢惀┤ 砮壤崟嗚┺ 瞽兌徨孌伻咕脩妮按揑巡⇐卜侻ㄖ⇐敓戲巡▾ ㊦勷孤婧夼巡⇑ 壯┗ 宕严┆ 崹┳ 奶嵩任⊡乙噭瞽呋圴┗ 咕咪圴ㄖ瞽乙媮阣ᶜᵍ▾ 咕咪圴ㄖ阣ᶜᵍ┳ ┰ 瞽× ┳ 揓午ᵐᵃ剃咕咪砮堜匏昐咕咪囂丅砮堜⇑ 啞唸吤窇咕⊡俠└ ⊡ピ┣ 嫊瞽⊡俠啞唸励乙嬔(ㄙ)瞽巡堎⇐巡孍嫽峎侔晏卻壨┗ ┼ 戰圴徼匏昐阣ᶜᵍnm啞藷瞽噻僝回丁撵吗嫽回⊡猛怫后截娼剃nm僈冗回+回帛ᶜᵍ⇑ 妠嗺┻ ┐ 瞽⊡ピ啞唸叡× 嚦媝偁瞽俏扚傚獷丅岓优囈瞽阣ᶜᵍ呀关寀慮噉团廛奶瞽阣ᶜᵍrad仞京孌巡堜呀瞽搔劐壨吳咪截孌噉团廛奶ㄖ⇑ 嶜摺┘ 嘎咭(ㄅ)孌巡堜她砮墠× 壨┳ 勲ㄹ┤ 哙婧寀孳寁瞽┤ 砮nm丅墇┼ 爪⇐ 亢姃⇐侯告丅テ嚯侮怫失堳瞽僥嬝砮剃嗺儴嗺俟孌巡堜冯瞽┓ 慮捗呀挽咘壨nA、 攉ㄧ悪剃瞽慮異咘壨峎侍憤励告憉匏鱸mV瀆墆頀嫙瞽傴啞┤ 徨呉呜傴吔瞽ピ峇囪獷⇐ᶜᵎ乍⇐匸声MW揎孻嵩⇑ 壨庈傾嵩恪噱啞摽嶜摺┘ 嘎(ㄅ)孌巡堜瞽呜嵩ㄖ┳ 娲卄扦扮⇔3. # 婓截└ ┼ 戰囤μℓ回瞽僈冗ㄖ┳ ┣ 戡蹙06# 嘝嚶暩⇐ ᵊ▫┆ 戰蹙/ k njJ 嘝嚶暩嫽瞽伶┳ 咦冯娼剃瞽壨娼剃僈冗ㄖ叼哖咍俍⇑ rad仞京孌巡偁┳ 噣堳回⊡匏呖♫堜埑她任⊡瞽二咕慆揮她娼剃瞽峎侍└ 偁嫀截冽励妣瞽剃恺┓ 媦偯瞽憴サ⇐嘜卄ㄖ嫽呋ᵀᶜ嵩⇑ 傚嗔瞽壨嘐恺屾壨◂ 啞豁慮媝┤ 搔堡ㄴ噻劂啞唸她侚墠瞽啞唸nm懇サこ偊瞽兢伉姠呀挽ピ偨励啞摽瞽▾ シ嘜卄乙徼⇑ 僕懹敓戲巡伉┰ 六┤ 她关壨巉佯全瞽堡ㄴ伉勓咦┤ 瞽壨巡偁┳ ナ妣截妣瞽刚憰揑峚噻倘匏侧扉僕懹密巡瞽nA憤励告姃⇐亼匿瞽壤崟丅墇鱸mV敓奈└ 処厧撐も⇑ 伉僕懹敓戲巡啞摽吤揖瞽俵┗ ᶜᵒ嫽■ 傚┏ 嫀嵳侩傸孌巡堜壨嘐恺屾壨◂ 偯刜乙哑瞽乙ㄴ┳ 崭嵳侩傸⇐嵳侩傸⇐墻嵳侩傸瞽家哖伉㊀巡唗严┤ 瞽崭嵳侩傸她こ壽呀挽咍抄瞽伉嗔佢娘┐ 傚傻回┤ 固一阣ᶜᵍ┏ 嫀嵳侩傸孌巡堜甍彐咕叼啞諾瞽阣婗└ ㊀巡唗严吳呉呜儻写瞽怜呉家哖慆┳ ン娩瞽峎俟┳ 砮严堰尤唤● 阣丨咍偁勴咦こ掙⇑

4 结语

妛ㄟ瞽伉砮严堰尤冽ㄩ吵妍┤ 僿▾ ㊦チ㉿デ噻鼻┓ 吡阣撣她ㄟ阣┐ 瞽砮堜妒嬝懹挲傚砮堜乙哑勴咦阣丅咍撣徥嘪瞽噱(ㄅ)砮堜乙哑搆佚庹埘妧◆└ ■ ◆ 她吵兑壩囊惟媮憎慹瞽(代)傚寔匷婚♂嗓兑尰爷二咕扇徥劂┻ ⇑ 嘐恺屾壨勴咦伶┳ 啞丅捼♫ ⇐偯剃家哖ン娩瞽傚┗ 侜咭佢恺峎侍冔嫐击憰nA摠她偁妛啥乙哑吤噱瞽伉噱(ㄅ)砮堜乙哑搆佚┤ 偶伉全捚她关壨ㄟ呼⇑ 嘐恺屾壨┤ 她偁ㄗ⁻关啞諾扃揚喤乿nA咕叼卵掃咾崨咭恺勃佢恺兟勸瞽嬔卄揯侚墠嗕撐瞽尅姁◂ 仗乙哑呀挽瞽阣撣儩× 叼塺⇑ 咤吐寀慮傚噱(ㄅ)砮堜乙哑搆佚┤ 嘐恺屾壨勴咦甍彐乙哑nmᵐᵃ墇瞽ナ伉砮严乙哑諾偯丁μℓ励咕咪卄μℓ堜藷偯┤ ☞ㄩ吳呜瞽nAᵐᵃ午恺恪└ 嘐妠嵩恪㊨扇☞ㄩ瞽阣丨┤ 傌她家响ざ刻⇑

参考文献：

Y/[ 懣ㄟ*憚傖*塼惓僭*燎,㊀噣┤ 4嫀噣圴刜婗慴ㄩ她嘐恺屾壨啞藷吤噱娀媲Y卜,孤來└ ┗ 壨卄偕严*0. 00*1. &3'8!0 +13,

Y0[ 彥劗接*憚ㄴ偬*犇制偤*燎,慲(ㄨ)兡噱(ㄅ)砮堜乙哑丁噱(ㄅ)砮墠偕娀媲埆垱寁忏乙哑Y卜,┤ 份噱(ㄅ)偕咭凰*0. / 7*12&1'8 024+03/,

Y1[ 巃屈嶝*苓斌斌*技傣婰,嘐恺屾壨噱啞摽嚦彐砮严声㈜健戡Y卜,┤ 份■ 嘎チ脩侧偕偕匀&唾埘媴偕堃'*0. / 7*03 &2'8 06+1/,

Y2[ 咧份塻*塼マ*捕▉ ざ*燎,尐毘砮严┤ 噎峌戡孌◆堜 0+&0+嘗嶜佢'+0+声佢嘝佢+墆儱戡她啞摽Y卜,ㄡ╚ 勴咦* 0. 0. *23&4'8406+410,

Y3[ 俵┗ *憋吤岡*憚掽*燎,┏ 嫀嵳侩傸孌巡堜嘐恺屾壨◂ 偯刜乙哑凵哑Y卜,僖├ 卄儩*0. 0. *27&2'8*71+73,