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ISSN 1462 2815

POISONING BY PLANTS AND TRADITIONAL MOROCCAN PHARMACOPOEIA PRODUCTS: AN ANALYSIS OF REPORTS IN THE MOROCCAN POISON CONTROL AND PHARMACOVIGILANCE CENTRE FROM 2010 TO 2022

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DOI: 10.5281/zenodo.13643204

Abstract

Introduction: In Morocco, the utilisation of plants and products from the traditional Moroccan pharmacopoeia (PTMP) plays a significant role in popular therapeutic practices. However, plant poisoning and PTMP are not negligible. The objective of this study was to describe the cases of PTMP poisoning notified to the Moroccan Poison Control and Pharmacovigilance Centre (MPCPC) over a period of 13 years. **Methods:** This study employed a retrospective descriptive and analytical approach to examine cases of intoxication by plants and PPTM reported to the MPCPC between 1 January 2010 and 31 December 2022. **Results:** During the study period, the MPCPC received 2016 cases of intoxication involving 183 plants and PPTM, with an average of 155 cases per year and 3.6% of all intoxications from all causes for the same period (except the bites and envenomations by scorpion). The majority of cases of poisoning occurred in urban areas (80.48%), predominantly in the home (82.69%), and were isolated incidents (76.86%). The mean age of individuals who had been intoxicated was 19.44 years, while the mean age of those who had died was 17.79 years. The data indicated that females were the most affected sex, with a sex ratio of 0.83. The most common cause was accidental (89.25%). The most common cause of death was ricin (14.64%). The primary route of intoxication was oral (89.87%). In 56.79% of cases, patients exhibited symptoms, with the majority presenting with gastrointestinal signs (38.76%). The outcome was specified in 68.30% cases and was fatal for 75 cases (5.45%). Among death cases, 54.66% were less than 20 years old.The Atractyls gummifera glue was responsible for 21.33% of cases of deaths (16 deaths). **Conclusion:** The incidence of poisoning by plants and PTMP is considerable and worthy of further investigation. It is important to note that plants and PTMP can contain potent chemical compounds that are responsible for significant toxicity, which can in some cases be fatal. It is imperative that the utilisation of plants and PTMP in Morocco requires increased vigilance and continued awareness.

Keywords: Poisoning, Plants, Traditional Pharmacopoeia Products, Morocco.

1. INTRODUCTION

Despite advances in pharmacology, traditional medicine (TM) is experiencing a resurgence and is a first choice for several populations around the world [1, 2].

The proportion of individuals utilising unconventional therapeutic modalities increased in USA from 33.8% in 1990 to 42.1% in 1997 (P < or = 0.001) [3]. However, the prevalence of their use varies between different populations and regions of the world. The estimated prevalence rates are 25.9% in Europe, 35% in the United States, 40% in China and 80% in Canada (4, 5).

Similarly, in the United States, there were 425 million visits to providers of unconventional therapies in 1990, which exceeded the number of visits to conventional physicians (388 million). The financial outlay associated with the utilisation of TM was approximately $13.7 billion, which is comparable to the $12.8 billion expended annually on all hospitalisations in the United States [6].

In Africa, the use of traditional medicines by the general population is widespread, with prevalence rates ranging from 85% in Burkina Faso and Nigeria, 86% in Ghana, to 90% in Burundi and Ethiopia (7, 8). A study conducted in Bamako, Mali, in 2007 revealed that 57% of parents sought treatment for their child's diarrhoea from traditional healers [9].

In Morocco, the use of medicinal plants is a deeply entrenched practice within the population [10]. Indeed, the country's geographical location, climatic and edaphic data, and soil diversity provide it with a significant floristic biodiversity [11, 12]. Morocco is therefore considered to be one of the countries of the Mediterranean with a particularly diverse flora, which provides the population with a wide range of medicinal plants. This rich heritage of traditional knowledge and expertise has enabled the development of a highly sophisticated therapeutic plant base [13]. Furthermore, the accumulation of ancestral knowledge and expertise is the result of the intermingling of Amazigh, Arab-Muslim, Jewish and Iberian civilisations [11, 14]. In addition to these socio-environmental assets, which encourage the Moroccan population to use phytomedicines, are added users confidence in the effectiveness of phytomedicine and its relatively cheaper cost [15]. However, the high cost of official medicine is one of the other factors that have led the WHO and governments to reconsider traditional medicine [16].

Nevertheless, the challenges facing public health in relation to TM can be considered to be twofold: Firstly, TM plays an important role in the provision of healthcare to populations, and thus constitutes a critical factor in achieving universal health coverage. Secondly, the informal use of TM has been identified as a potential health risk. Inappropriate use of plants can lead to adverse effects, some of which may be life-threatening [17, 18, 19].

In the other hand, the notion that plants are inherently harmless is pervasive, largely due to the perception that they are natural. Consequently, the population employs them in various contexts and consumes them without fully acknowledging their toxic properties [20]. The products in question are frequently a "mixture" of plants, the preparation and consumption of which is not accompanied by the requisite knowledge and understanding. It is acknowledged that plants and PTMPs may contain potent dangerous chemical compounds that can cause adverse effects and toxicity [20]. The issue of poisoning by plants and PTMPs represents a significant public health concern in Morocco. A study conducted by the MPCPC revealed that plant and PTMP poisoning constituted 5.1% of all poisoning cases reported between 1980 and 2008 (exclusive of stings and envenomations by scorpions, which are recorded separately) [21]. Moreover, the same source (MPCPC) indicates that the mortality rate from these poisonings remains one of the highest in Morocco (7.3%) [21].

Prior research conducted at the same institution (MPCPC) indicated that plants were responsible for 3 to 5% of all poisonings, yet resulted in a relatively high mortality rate (17%) [22, 23]. In a separate study, the average direct cost of treating poisoning in Morocco (all causes combined) was estimated at USD 157, which represents 60% of

the national minimum monthly wage. The total direct medical costs constituted 80% of the total, while the direct non-medical costs accounted for the remaining 20% [24]. The mean length of hospitalisation for children who had been poisoned was 2.15 ± 1.87 days, with a range of 0 to 10 days [24].

It is thus imperative to continue monitoring the epidemiology of this particular poisoning, particularly given the dearth of available data on the subject.

The objective of the present study was to examining cases of poisoning by plants and PTMPs, encompassing the characteristics of the poisoned, the type, circumstances, severity, symptoms, and evolution of the poisoning, as well as the characteristics of the plant(s) and/or PTMP involved.

2. METHODS

This was a retrospective study with a descriptive aim, examining cases of poisoning by plants and PTMPs over a period of 13 years, reported between 1 January 2010 and 31 December 2022. The data was collected by the Toxicovigilance Unit of the Moroccan Poison Control and Pharmacovigilance Center (MPCPC) through two information systems (Toxicovigilance and Toxicological Information), and was reported on two types of forms (reporting forms and medical files).

The data were recorded in a national database and subsequently analysed using Excel and Epi Info 3.3.2 software.

The plants are identified by their Arabic or Amazigh vernacular name or their French common name. The scientific name of the plant has been provided in accordance with the international binomial nomenclature, which is designated by two Latin words (genus then species). The term "mixture" is used to describe herbal preparations and pharmacopoeia products that have been pulverised or combined with honey or oil.

The analysis encompassed an investigation into the frequency, temporal distribution (year), spatial distribution (environment), characteristics of the poisoned individual (sex, age), and the circumstances, location, symptoms, severity assessment, and evolution. The age groups employed are those delineated by the World Health Organization (WHO) International Programme on Chemical Safety (IPCS): neonate (less than 4 weeks), infant (4 weeks - less than 12 months), toddler (1-4 years), child (5-14 years), adolescent (15-19 years), adult (20-74 years), elderly (>75 years) **[**25].

The severity of the poisoning was evaluated according to the Poisoning Score Severity (PSS) scale [26]. The grading system employed was as follows: Grade 0 (no signs or signs not related to intoxication), Grade 1 (signs resolved spontaneously), Grade 2 (signs marked or moderate, treatment needed), Grade 3 (severe poisoning with life-threatening potential), Grade 4 (fatal poisoning) [26].

The symptomatology was classified in accordance with the WHO Adverse Reaction Terminology (ART) [27].

3. RESULTS

During the study period, the MPCPC received 2016 reports of poisoning involving 183 plants and products of the traditional pharmacopoeia amounting to an average of 166 cases per year. This represents 3.6% of all poisonings for the same period, with the exception of those caused by scorpion bites and envenomations.

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3.1 The Distribution of Results According to Declaration Characteristics

The distribution of results according to temporal parameters demonstrated that the evolution of declarations by year exhibited a notable increase in 2014, with 291 cases, which was followed by a surge during the period of the global pandemic caused by the novel coronavirus, resulting in 126 additional cases. This was in contrast to the preceding year, 2019, which had seen a decline (Figure 1).

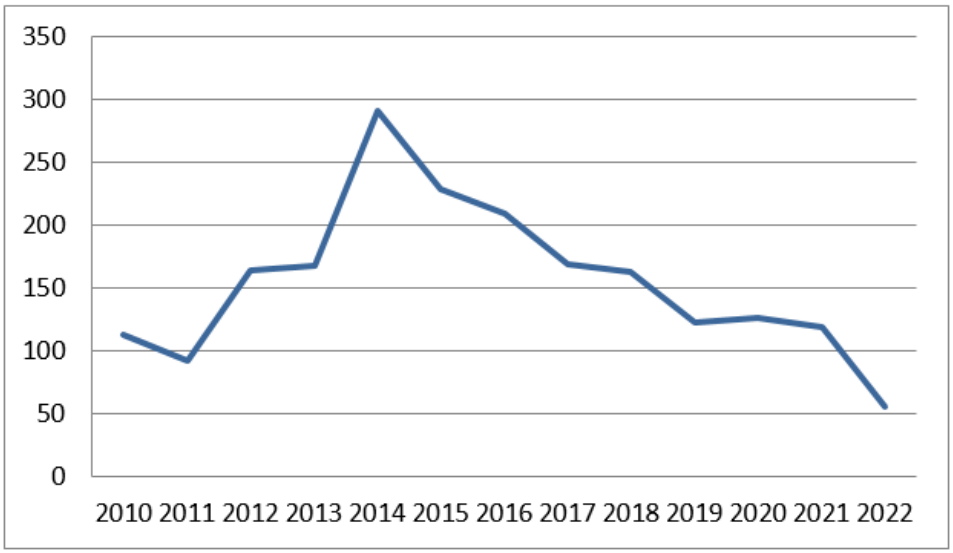

Figure 1: Trend in reports of poisoning by plants and products from the Moroccan traditional pharmacopoeia by year, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

In contrast, the majority of plant and PTMP poisonings occurred during the spring, with a peak incidence in April (13.9%). Figure 2 illustrates the trend of reports by month; however, it should be noted that in 880 poisoning cases, the month was not specified.

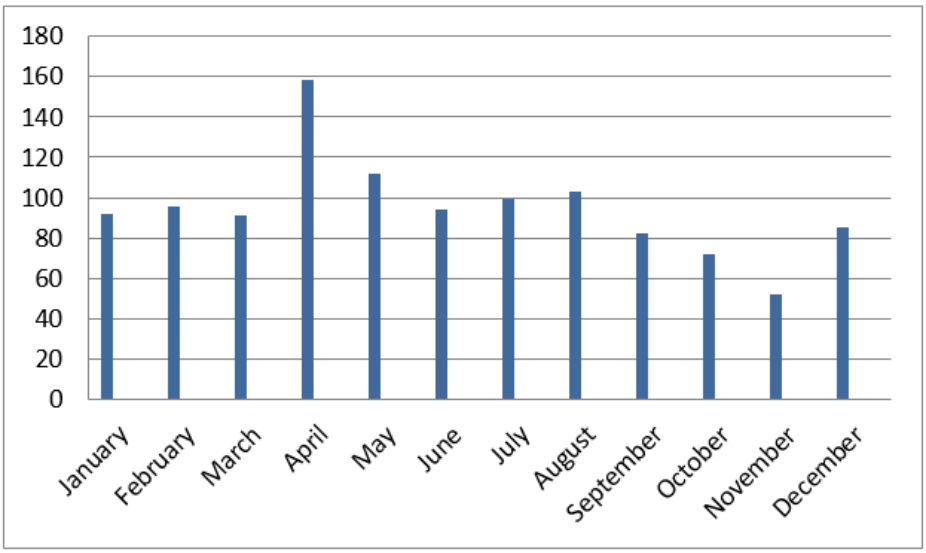

Figure 2: Trend in reports of poisoning by plants and products from the Moroccan traditional pharmacopoeia by month of the year, Moroccan poison centre, 2010-2022.

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Information was received from all regions, although the frequency of occurrence differed from year to year and from region to region. As illustrated in Figure 3, the regions of Rabat, Casablanca, Marrakech and Fez exhibited the highest number of reports.

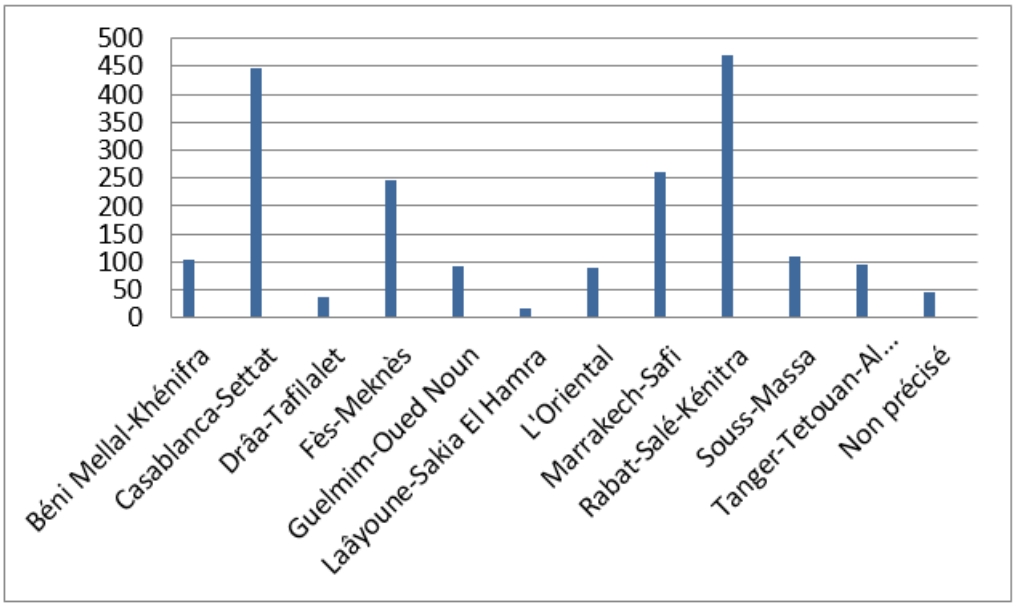

Figure 3: Reports of poisoning by plants and products of the Moroccan traditional pharmacopoeia by region of the Kingdom, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

The majority of reports were submitted by health professionals (86.89%), calls to the toxicological information unit were the most involved mean for Reporting (77.94%). Table 1 illustrates the distribution of cases of poisoning by plants and PMTP, classified according to the type and subtype of report.

Table 1: Distribution of cases of poisoning by plants and products from the traditional Moroccan pharmacopoeia according to the type and sub-type of reporter, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Type of reporter	Number of cases	Percentage (%)
Healthcare professional	1643	86,89
Public	248	13,11
N active	1891	100%
Sub-type of reporter	**Number of cases**	**Percentage (%)**
Mail response	324	16.50
Telephone calls	1530	77.94
Surveys	33	1.68
Press	75	3.83
WebSite	1	0.05
N active	1963	100%

3.2 The distribution of results according to poisoning indicators

The most common cause was accidental (89.25%). The majority of poisonings occurred in urban areas (80.48%), particularly in the home setting (82.69%). Additionally, the majority of cases were isolated (76.86%) (Table 2).

Table 2: Distribution of cases of poisoning by plants and products from the traditional Moroccan pharmacopoeia depending on the circumstance, type, location and environment of the poisoning, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Circumstance	Number of cases	Percentage (%)
Accidental	1570	89.25
Voluntary	189	10.75
N active	1759	100%
Type of poisoning	**Number of cases**	**Percentage (%)**
Isolated	1518	76.86
Collective	457	23.14
N active	1975	100%
Poisoning environment	**Number of cases**	**Percentage (%)**
Urban	1377	80.48
Rural	334	19.52
N active	1711	100%
Place of poisoning	**Number of cases**	**Percentage (%)**
Home	1290	82.69
Public place	252	16,15
Workplace	18	1,16
N active	1560	100%

The distribution of cases of poisoning by plants and PTMP according to the subcircumstances of the poisoning revealed that 56.93% were classified as classic accidents, 27.79% were identified as adverse reactions, 5.19% were diagnosed as foodborne poisoning, and 1.95% were determined to be therapeutic errors. Nevertheless, the voluntary act was also identified in cases of attempted suicide (5.13%), abortion (1.3%), crime (0.94%) and addiction (0.94%) (Table 3).

Table 3 : Distribution of cases of poisoning by plants and products from the traditional Moroccan pharmacopoeia according to the sub-circumstance of poisoning, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Sub circumstances	Number of cases	Percentage (%)
Classic accident	965	56.93
Foodborne	88	5.19
Abortion	22	1.3
Criminal	11	0.65
Adverse reaction	471	27.79
Therapeutic error	33	1.95
Professional	2	0.12
Suicide attempt	87	5.13
Addiction	16	0.94
N active	1695	100%

3.3. Distribution of Results According to Poisoned Cases

The mean age of the poisoned was 19.44 years, with the adult age group exhibiting the highest level of exposure (Figure 4).

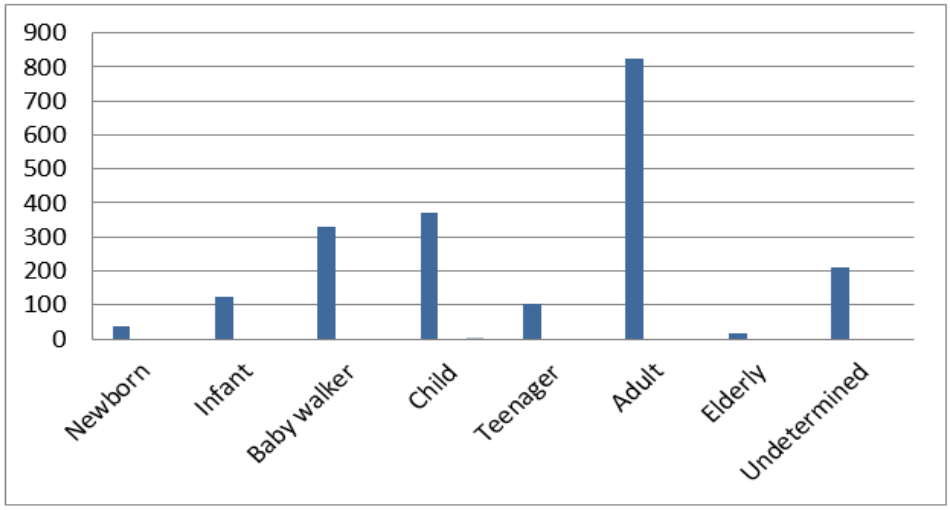

Figure 4: Distribution of poisonings by plants and products from the Moroccan traditional pharmacopoeia by age group, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

The female sex was the most affected with a sex ratio (M/F) of 0.83 in favor of the female sex (1011 cases), the male represented 845 cases, while in 160 cases the sex was not determined (Figure 5).

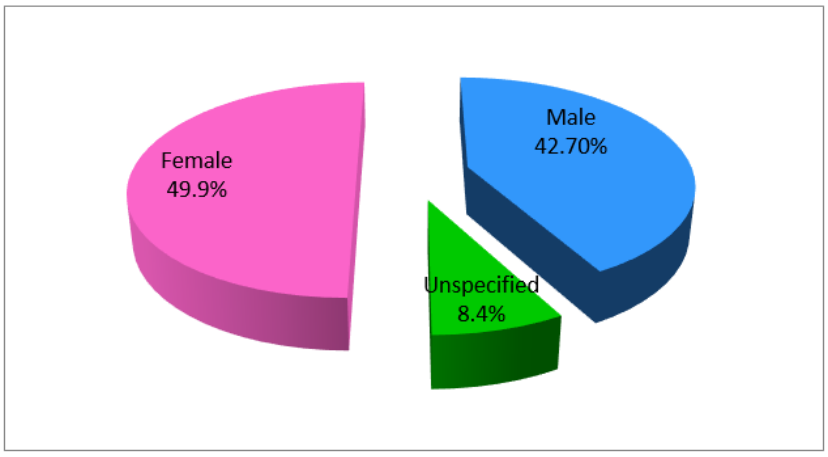

Figure 5: Distribution of poisonings by plants and products from the Moroccan traditional pharmacopoeia by gender, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

3.4. Characteristics related to toxicants: plants and/or traditional pharmacopoeia products

3.4.1. Plants and traditional pharmacopoeia products most implicated in poisoning incidents

Conversely, the distribution of the plants and PTMPs most frequently implicated in poisonings demonstrated that the plant or PTMP could not be identified in approximately 27.82% of cases. Of the identified cases, castor (Ricinus communis L., popular name ‘L'kharouâ’) was the most frequently implicated substance (14.64%), followed by thistle (Atractylis gummifera, popular name ‘Addad’) (12.92%).

Notably, ‘Ferraga’ (typically an elderly woman who provides various treatments for multiple pathologies she use mixtures from the traditional pharmacopeia, administering these concoctions orally and/or topically, especially to newborns and young children), was implicated in 29 poisonings. It is also noteworthy that mixtures of plants, which may be utilised by ‘Ferraga’ or other traditional practitioners, constituted 140 cases, accounting for 6.91% of the total (Figure 6).

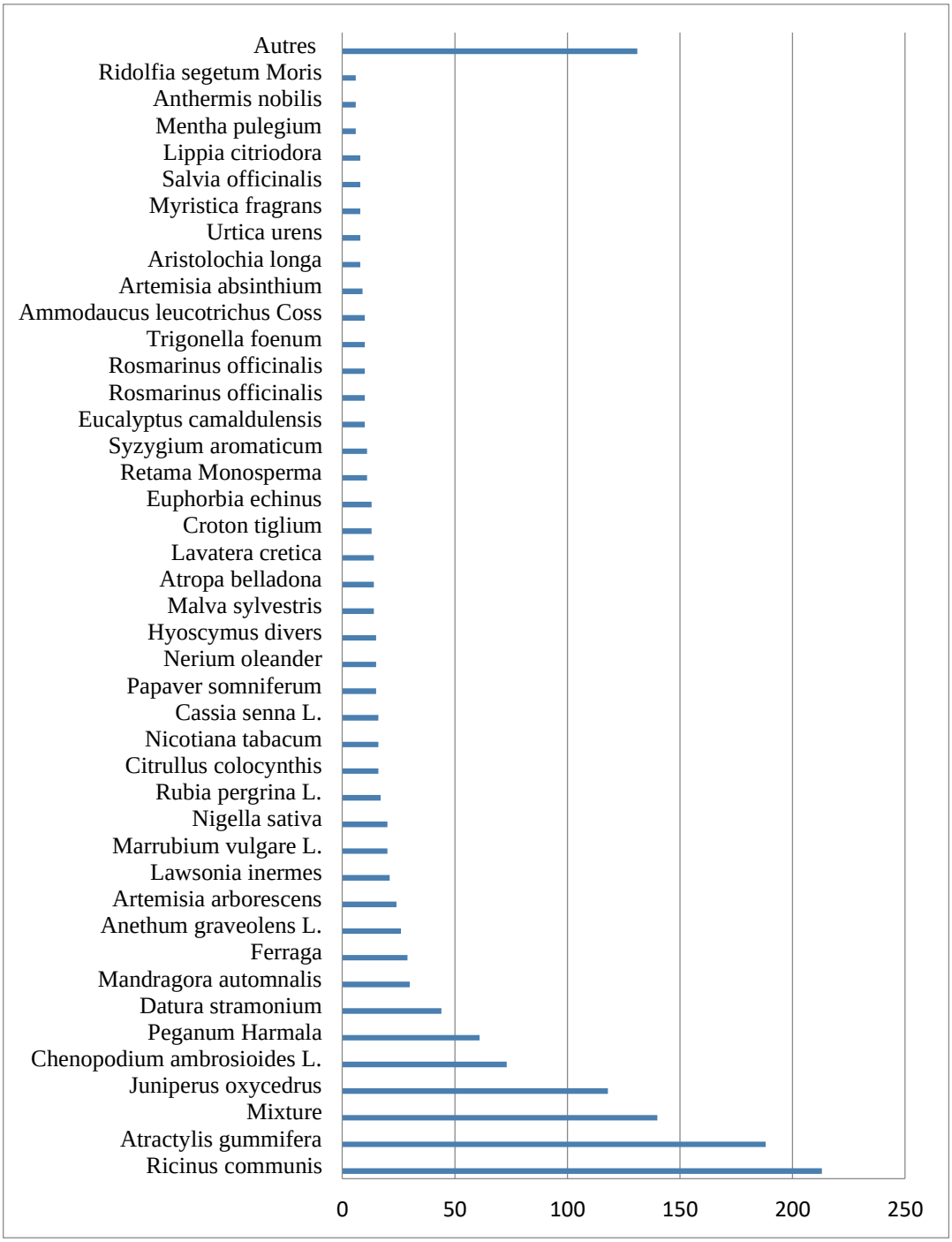

Figure 6: Distribution of poisonings according to the plants and products of the traditional Moroccan pharmacopoeia most involved in poisoning cases, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

3.4.2. Distribution of poisonings by oils of plant origin and essential oils most implicated in poisonings, MPCPC, 2010-2022.

Furthermore, plant-derived oils and essential oils were identified as the cause of 266 poisoning cases, representing 18.28% of all poisoning cases in which the plant and PTMP were identified (1455 cases). Accordingly, caddy oil (Juniperus oxycedrus oil, popular name 'Al qatráne') is the most prevalent cause of poisoning, accounting for 70.68% of cases, followed by castor oil (Ricinus communis L., popular name 'zit L'kharouâ') (7.89%). Conversely, essential oils and oils derived from plant mixtures whose names were not specified were responsible for 5.64% and 2.63% of poisoning cases, respectively (Figure 7).

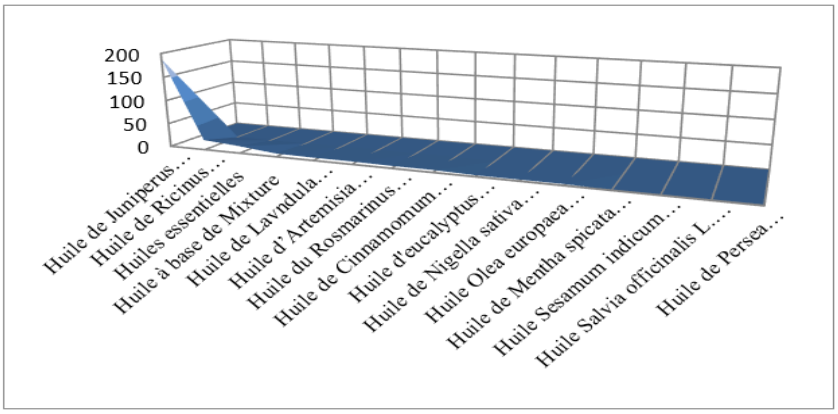

Figure 7: Distribution of poisonings by oils of plant origin and essential oils most implicated in poisonings, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

3.4.3. Distribution of poisonings according to the plants and products of the traditional Moroccan pharmacopoeia involved in intentional poisoning

A total of 136 cases of intentional poisoning involving plants and PTMP that were used in the intentionally for a variety of illicit purposes, including addiction, abortion, and suicide attempts. Intentional criminal poisonings (11 cases) involved plants and PTMP, with 63.63% to mixture (several associated plants), the distribution of which is illustrated in Figure 8.

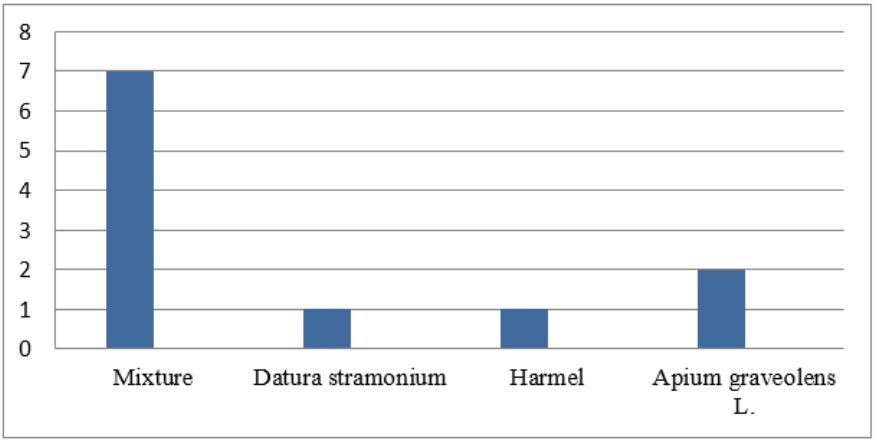

Figure 8 : Plants and traditional pharmacopoeia products involved in criminal poisoning, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

In the context of addiction (16 cases), plants and PPTM were identified as relevant factors, with 31.25% to Datura stramonium L. (known by many names: devil's weed, thorn apple, poison apple, angel's trumpet, popular name 'chedaq jmel') (Figure 9).

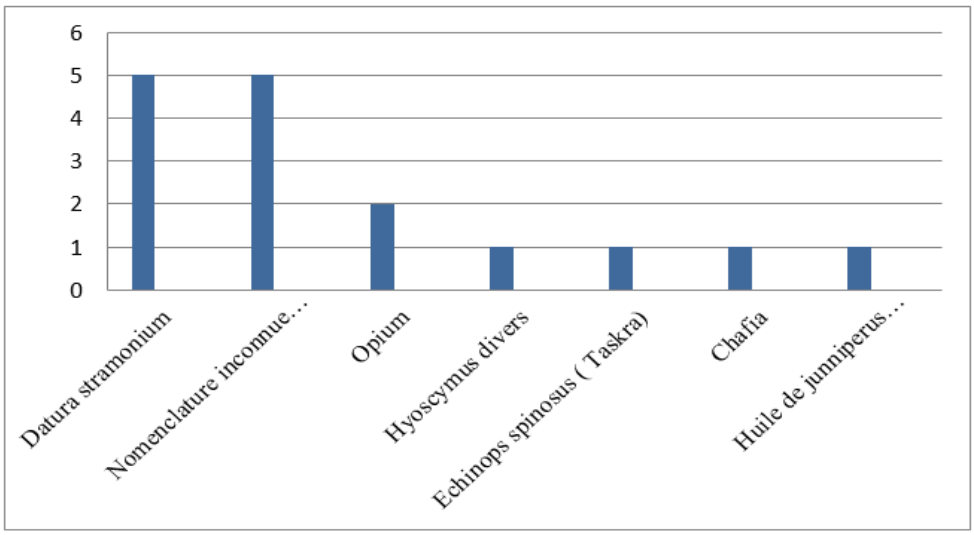

Figure 9: Plants and traditional pharmacopoeia products involved in addiction, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Conversely, the poisoning of individuals following abortions (22 cases) involved the administration of distinct plant species, with 45.45% to Peganum harmala L. (popular name ‘Harmel’) (Figure 10).

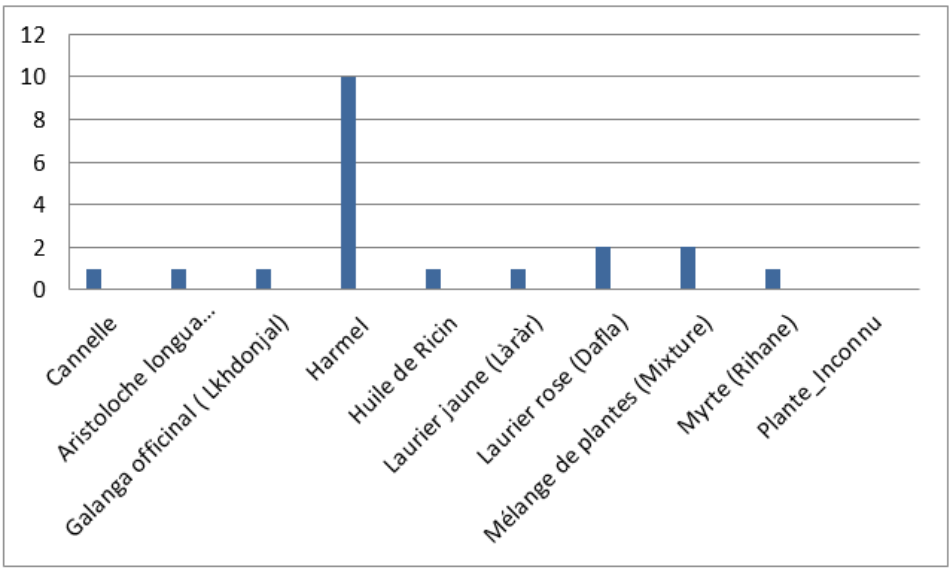

Figure 10: Plants and products from the traditional Moroccan pharmacopoeia involved in poisoning following abortions, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Nevertheless, suicide attempts (87 cases) were associated with the use of plants and PPTM, 19.54% attributed to glue thistle (Atractylis gummifera, popular name ‘Addad’), 10.34% to a mixture of plants, and 8.04% to Peganum harmala L. (popular name ‘Harmel’), as illustrated in Figure 11.

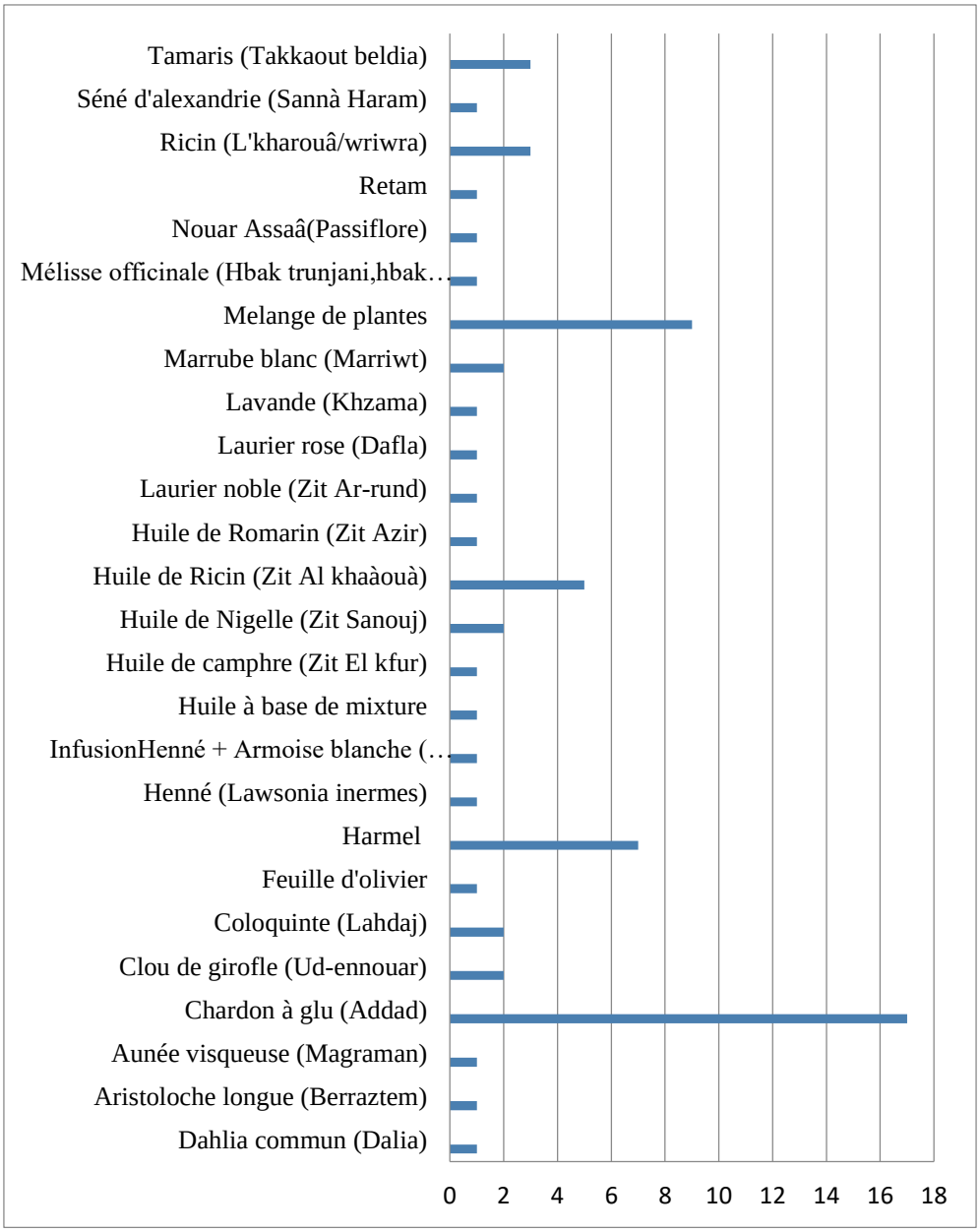

Figure 11: Plants and products from the Moroccan traditional pharmacopoeia implicated in suicide attempts, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

3.4.4. Plants involved in Deaths

A total of 75 cases of death were recorded, with 21.33% attributed to glue thistle (Atractylis gummifera, popular name ‘Addad’), 13.33% to a mixture of plants (used by ‘Ferraga’), and 8% to goosefoot (Chenopodium ambrosioides, popular name 'Mkhinza') and castor (Ricinus communis L., popular name ‘L'kharouâ’) (Figure 12).

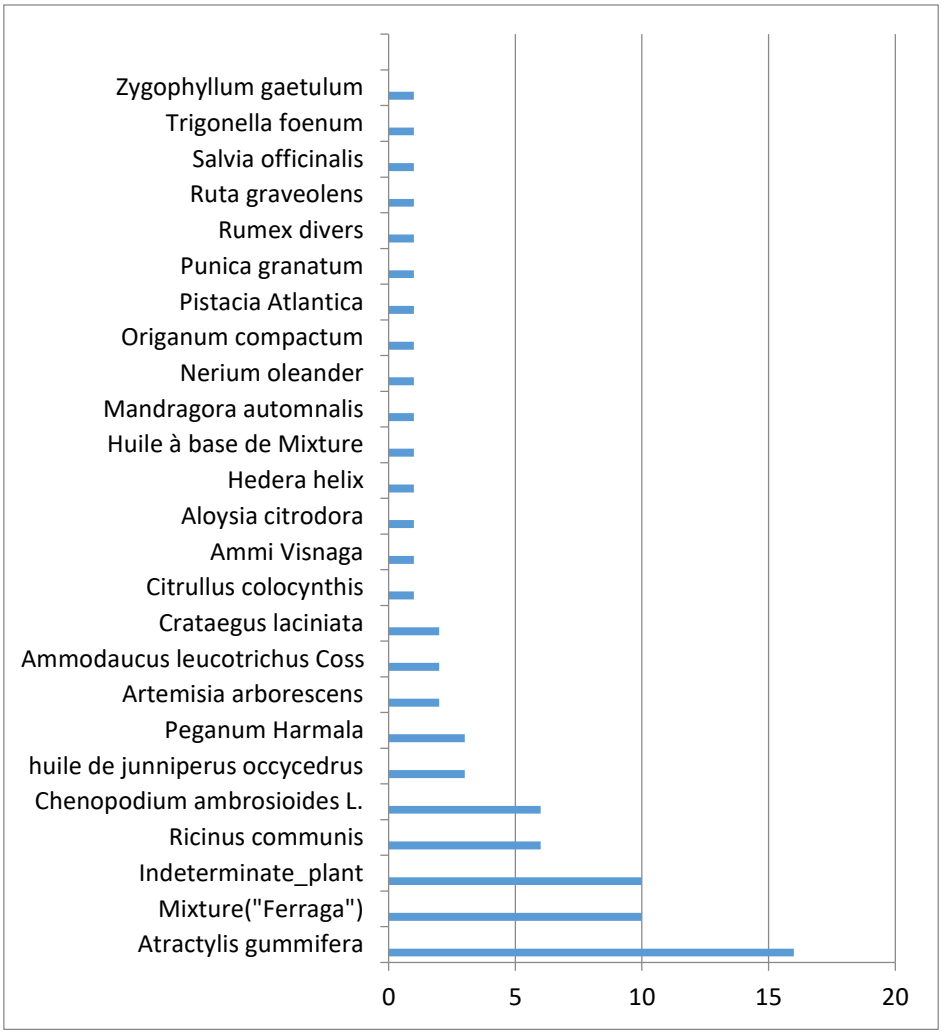

Figure 12: Distrubtion of cases of death according to the plants involved

3.5. Distribution of results according to the clinical characteristics of the poisoning

3.5.1. According to the gradation

As illustrated in Table 4, the Poisoning Score Severity (PSS) revealed a notable increase in the prevalence of grade 2 (moderate) poisoning, rising from an initial 21.71% to 40.5%. Additionally, there was a significant rise in the incidence of grade 4 (fatal) poisoning, increasing from an initial 0.28% to a final 3.77%.

Table 4: Distribution of cases of plant poisoning according to gradation, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Grade	Initial grading		Final grading	
	Number	(%)	Number	(%)
0: No signs	128	7,07	221	11,12
1 : Spontaneously regressive signs	106	5,86	273	13,73
2 : Pronounced signs	393	21,71	805	40,50
3: Severe intoxication	98	5,41	137	6,89
4 : Fatal poisoning	5	0,28	75	3,77
Unclassifiable	1080	59,67	477	23,99
N active	1810	100%	1988	100%

3.5.2. Depending on the route of administration

In the cases where the route of administration was reported, it was predominantly oral (89.87%) (Table 5).

Table 5: Distribution of cases of plant poisoning according to the route of administration, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Route of administration	Number of cases	Percentage (%)
Cutaneous	130	7.08
Inhalation	37	2.01
Inhalation and dermal	2	0,11
Ocular	6	0,33
Oral	1651	89,87
Percutaneous	3	0,16
Rectal	3	0,16
Vaginal	5	0,27
N active	1837	100%

3.5.3. According to symptomatology

In instances where a diagnosis was reached, 56.79% of patients exhibited symptoms (Table 6).

Table 6: Distribution of cases of plant poisoning according to symptoms, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Symptomatology	Number of cases	Percentage (%)
Symptomatic	937	56,79
Asymptomatic	713	43,21
N active	1650	100%

3.5.4. Depending on the devices concerned

The majority of patients presented with gastrointestinal symptoms (38.76%), followed by neurological symptoms (22.94%) (Table 7).

Table 7: Devices affected during poisoning by plants and traditional pharmacopoeia products, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

The system reaches	Number of cases	Percentage (%)
Gastrointestinal disorders	654	38,76
The nervous system	387	22.94
General health disorders	139	8.24
Respiratory system	109	6.46
Cardiovascular system	92	5.45
Skin and related disorders	48	2.84
Urinary system	43	2.54
Osteo-muscular system	42	2.48
Psychiatric disorders	41	2.43
Liver and biliary tract	38	2.25
Bleeding and coagulation	31	1.83
Reproductive system	27	1.60
Visual system	17	1.01
Other	14	0.83
Cochleovestibular	5	0.30
N active	1687	100%

3.5.5. According to the evolution

In 31.69% of cases, the final outcome was not ascertainable. The overall lethality rate was 5.45%. Table 8 illustrates that consequences were observed in 1.1% of cases.

Table 8 : Evolution of poisoning by plant and traditional pharmacopoeia products, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

Evolution	Number of cases	Percentage
Favorable	1287	93.45 %
Sequelae	15	1.1 %
Deaths	75	5.45 %
N active	1377	100%

A total of 75 deaths were recorded, with 54.66% of the deceased being under the age of 20 (Figure 13).

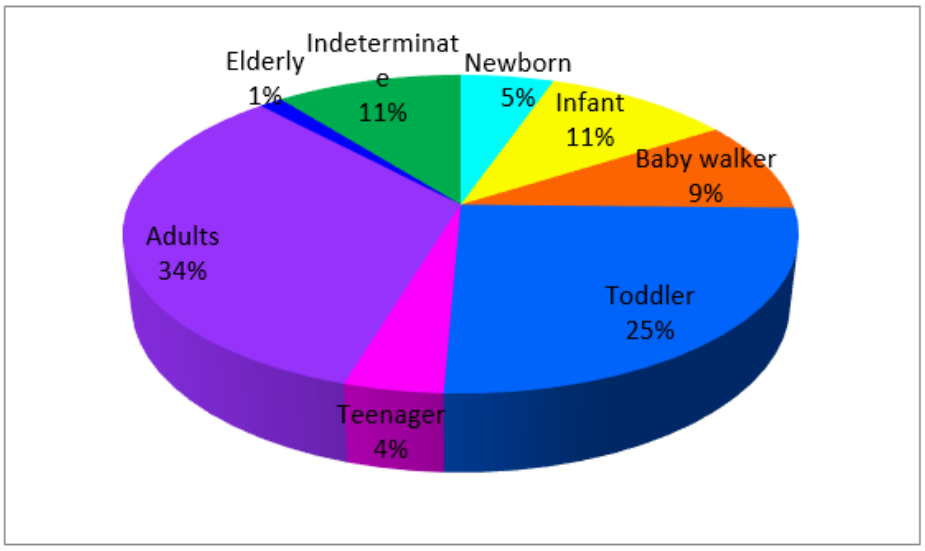

Figure 13: Distribution of results by age group of deceased by plant and traditional pharmacopoeia products, Moroccan Poison Control and Pharmacovigilance Centre, 2010-2022.

4. DISCUSSION

A total of 2016 cases of plant and PTMP poisoning were reported to the MPCPC over the course of the 13-year study period, representing 3.6% of all poisoning cases (excluding PES). However, the results of the MPCPC study, conducted between 1980 and 2008, indicate that the MPCPC documented 4,287 cases of plant poisoning, representing 5.1% of all cases of poisoning during the same period (exclusive of PES) [21]. In Morocco, this type of poisoning is subject to a considerable degree of under-reporting [28], which is particularly evident when compared to the findings of the Brussels Poison Centre, which received 59,313 calls in 2018. When all causes are considered together, the category of plants and fungi accounted for 1,943 cases. This figure is approximately 12 times higher than the number reported to the MPCPC, given that the Belgian population is only approximately one-third of the Moroccan population [29]. This discrepancy can be attributed to the underestimation of the toxic potential of plants by the Moroccan population, who tend to perceive all natural products as harmless [20].

In this study, the primary age group for this type of exposure was adults, with a greater prevalence of females. As in European and American series, the child remains the most affected in accidental circumstances [30, 31, 32]. A Chinese series is comparable to our own [33]. Indeed, in Morocco, adult women elect to utilise plants and PTMP for therapeutic purposes. This practice is further reinforced by the resurgence of media coverage of plant-based therapeutic advice, which also prompted an alert from the MPCPC in 2013 [34].

Furthermore, the identification of consumed plants is a challenging undertaking, largely due to the vast array of vernacular names that exist throughout the kingdom. In some cases, the same names are attributed to different plants depending on the region [11]. However, the plants involved in poisoning vary according to the flora and socio-cultural habits of each country, as evidenced by studies such as those conducted by [33, 35].

The primary cause of poisoning in this study was ricin (Ricinus communis L.), which has various popular names in Morocco (Wriwra, Kharwaà, Kran'k, Tazartûchan, Wararû, Wrûri, Wayrûrû) (213 cases). The castor bean is a source of ricin, a highly toxic glycoprotein. Ricin is a cytotoxic poison that acts by inhibiting protein synthesis [36]. Indeed, the onset of symptoms typically occurs within a few hours of ingestion, leading to a severe clinical picture, particularly in children, for whom ingestion of as few as three seeds can be fata [36]. l. However, the minimum number of seeds that have been documented to cause death in a patient is two, as evidenced by a case report in the literature [37].

Nevertheless, the estimation of the extent of intoxication based on the number of seeds ingested is challenging due to the influence of various factors, including the ricin content, seed size, seed humidity, and the grinding method (chewing/mastication) [38, 39]. The neurological signs observed (cramps, muscular weakness, vision problems, altered consciousness, convulsions) are more likely to be the consequence of massive hydro-electrolyte losses [38]. Furthermore, toxic encephalitis and papilledema may be observed, as well as hepatic necrosis and renal failure, which typically manifest between two and five days after ingestion and result in damage to the adrenal glands. In 2011, an MPCPC alert was issued [40].

In this study, the glue thistle (Atractylis gummifera, popular name is ‘Addad’) was identified as the second most common plant responsible for the occurrence of poisonings (188 cases), but the most common plant responsible for cases of death (16 deaths or 21.33%). However, in Morocco, 66.7% of cases of death were observed in children, which contrasts with the findings of certain authors [41], of which 77.6% were due to thistle.

The species is indigenous to the Mediterranean region and is found in Morocco in all regions, with the exception of the Marrakesh region, the Anti-Atlas and desert or arid areas. The plant is regarded as both poisonous and medicinal. Furthermore, it is available for purchase without a prescription from any herbalist and in traditional markets [11]. The consumption of this plant is characteristic of siblings of children living in rural areas, particularly shepherds who ingest it due to its sweet taste, unaware of the potential dangers associated with it [41].

A further study has demonstrated that poisoning by Atractylis gummifera L. is the primary cause of mortality associated with plant poisoning, particularly in children [42]. Indeed, between 2009 and 2018, the MPCPC received 98 cases of poisoning by

Atractylis gummifera L., commonly known as glue thistle. Of these cases, 41.8% involved children. A total of 13 patients died, corresponding to a case-fatality rate of 13.26%.

The majority of these patients were children (92.3%) [43]. All parts of the plant contain the toxic principles of glue thistle, namely atractyloside and carboxyatractyloside or gummiferin. These are poisons that block the oxidation-reduction reactions involved in the oxidative phosphorylation of ATP formation at the mitochondrial inner membrane[44]. In the most severe cases, additional complications may manifest in the respiratory, cardiovascular, and hepato-renal systems [44]. The majority of cases are fatal [43]. In consequence of the occurrence of a considerable number of cases of poisoning, frequently of a serious or fatal nature, this plant was the subject of two MPCPC alerts in 2016 [45] and 2020 [43].

Furthermore, this study demonstrated that oils derived from plant sources constituted an additional cause of poisoning, with 266 cases identified. The most frequently identified substance was cade oil (Juniperus oxycedrus oil, popular name ‘’Al qatrane’’), accounting for 70.68% of cases. Nevertheless, it is noteworthy that cade oil is frequently utilised in customary Moroccan practices [46, 47].

In Morocco, consumers have unrestricted access to cade oil without a prescription [47]. However, the issue of cade oil poisoning is a cause for concern, both in terms of the number of victims reported and the severity of the cases [48]. The composition of the substance is complex, comprising a high proportion of hydrocarbons, including cadinene, phenols, primarily guaiacol and cresol [49]. Nevertheless, phenol is the most toxic component [50].

The absorption of phenol is rapid, with the majority of its hydroxylation occurring in the liver. However, when the quantity ingested exceeds the hepatic conjugation capacity, its oxidation results in the production of free radicals [50]. A study demonstrated that cade oil is utilized in both sexes and across various age groups, particularly in young children.

Specifically, 84.61% of the population, including 63.63% aged between one week and 12 months, represents a population at high risk in terms of phenolic toxicity [51]. Nevertheless, it has been documented that the ingestion of 50 to 500 mg of phenol in infants and exposure of the skin to phenolic solutions ranging from 80 to 100% has resulted in fatalities [52, 53]. Additionally, there have been reports of infant deaths following minor skin exposure to 1-2% phenol solutions [54].

The study also revealed that one of the causes of these intoxications is the plant mixtures often used by the 'Ferraga', a traditional healer for children, to whom she administers various treatments for different pathologies. The Ferraga's therapeutic approach is based, among other things, on the administration of plant mixtures orally to treat newborns and infants. The mixtures may contain a blend of more than 150 oils and plants [55].

These practices are in violation of the law and cause significant harm to a vulnerable population, with instances of severe or even fatal poisoning being reported. In a separate study, Draïss and colleagues presented data specific to the Marrakesh region. These findings indicate a significantly higher prevalence of poisoning associated with Ferraga practices compared to other forms of poisoning [56].

A total of 126 cases of children suffering from these practices were recorded in the paediatrics department of Marrakech University Hospital over a period of one year [56]. The MPCPC denounces these practices and highlights their inherent dangers, including the potential for indelible scars to be left behind [57].

Furthermore, the lack of hygiene provides a breeding ground for bacterial and viral infections, including hepatitis B and the AIDS virus [55]. The toxicity of the mixtures administered can also have severe consequences, including visual disorders, motor incoordination, delirious agitation, and acute renal failure, which can be fatal [11]. In 2011, the MPCPC issued an alert regarding the practice of Ferraga [57].

Chenopodium ambrosioides (goosefoot/Mexican tea, popular name ‘’Mkhinza’’) was also implicated in the deaths. This herbaceous plant belongs to the Chenopodiaceae family and is used in Morocco for its therapeutic properties, particularly as an antipyretic. However, it can be toxic if misused, especially as the toxic dose is very close to the supposedly effective dose [58]. The pharmacological effect (vermifuge activity) of this plant is explained by the presence of ascaridol [59]. Ascaridol is also responsible for toxicity through inhibition of complex I of the respiratory chain and inhibition of oxidation-reduction reactions at the mitochondrial level [58].

Anserin toxicity may also be related to contamination by fungal toxins such as aflatoxin or other heavy metals and herbicides [59]. Indeed, several cases of toxicity have been linked to anserin. Kaoubai et al. Have reported that the association between histological lesions and the patient's consumption of m'khinza suggests a toxic effect on the kidney [60], which is a limitation to the use of this plant, despite its analgesic, antispasmodic and vermifuge properties [61]. These intoxications can be serious and sometimes fatal In 2011[62], following several reports of serious adverse reactions associated with the use of goosefoot, the MPCPC issued a warning and recommended that the plant should not be used in children [58].

In this study, Peganum harmala L. (also known as Syrian remorsefulness, popular name ‘’Harmal’’) was the leading cause of voluntary intoxication, but also of suicide, addiction, criminal intent and accidental intoxication. The study by Achour et al. Documented 200 cases of intoxication due to Peganum harmala L. Therapeutic circumstances accounted for 32.5% of cases, followed by suicide (28.5%) and abortion (13.5%). The patients' clinical picture was dominated by neurological, digestive and cardiovascular signs, with 34.4%, 31.9% and 15.8% respectively, and 7 deaths were reported, with a fatality rate of 6.2% [63].

Another study reported the case of a 20-year-old woman intoxicated by Peganum harmala L. On admission, she was in a state of shock with agitation, vomiting and consciousness disorders, anaemia, thrombocytopenia, acute nephropathy, increased transaminases and a positive plasma bHCG. Cerebral CT revealed multiple areas of cerebral ischaemia with subarachnoid haemorrhage, while thoraco-abdominal-pelvic CT showed enlargement of the uterus and location of internal haemorrhage. [64]. The prognosis is generally favorable, excessive use of high doses of P. Harmala L. can lead to fatal evolution [64].

Administration of the aqueous extract at different doses taken intraperitoneal injection on male mice to severe symptoms of toxicity. These symptoms are presented by Drowsiness, hypoactivity, anorexia, isolation, bradycardia, difficulty breathing, exicitaion, death the results obtained show that, the highest dose killing all animals or

100% lethal dose (LD 100) is 10 g / kg for peganum harmala L. while for the maximum tolerated dose it is 1g / kg [65].

In this series, the addictions primarily involved Datura stramonium. One study reported a series of 1186 cases of exposure to Datura recorded by French poison control centres. Of these, 643 (54.2%) were considered to be deliberate, including 486 in the context of drug addiction and/or recreational use. The lethal risk of such poisoning is mainly due to the fact that these plants induce hallucinations and can therefore lead to self-inflicted harm [66]. In 2020, a case of serious poisoning following the consumption of datura leaves was reported by the Centre antipoison Grand-Est in July 2020. Four members of the same family had prepared and eaten datura leaves in a cooked dish, mistaken for horned tetragon leaves collected from their vegetable garden. They quickly showed signs of serious intoxication, requiring each of them to be admitted to intensive care [67].

In terms of presenting symptoms, toxic plants can be identified through the toxidrome exhibited by the patient. Consequently, toxic plants can induce a range of concomitant syndromes, with one prevailing [38]. A number of clinical classifications have been put forward with a view to facilitating the rapid recognition and management of patients who have been exposed to plant toxins. Accordingly, the toxins were classified into four categories: cardiotoxic, neurotoxic, cytotoxic, and gastrohepatotoxic [68].

In the absence of specific antidotes, the treatment of poisoning by this substance is largely symptomatic. In light of the aforementioned factors, decontamination may be recommended as a course of action, contingent upon the toxicity of the plant ingested, the symptoms generated, and the time of action.

The administration of activated charcoal may be a beneficial intervention in this type of poisoning [41]. Medical surveillance, based on the target organs of the plant, is frequently the only recommended approach, particularly when the patient is asymptomatic. Additionally, N-acetylcysteine was administered to four patients who had presented with liver damage, and a discernible improvement was observed in these four patients. Nevertheless, the efficacy of these approaches must be substantiated by randomized controlled trials against a placebo [69].

5. CONCLUSION

It can be stated that acute plant poisoning and PTMP are significant issues in Morocco. Such practices are typically reserved for adults who frequently consume plants for therapeutic purposes. They are responsible for the greatest number of deaths from toxic causes. It is imperative to address the ongoing concern of glue thistle poisoning. This phenomenon predominantly affects children, frequently occurring in a collective setting and resulting in a markedly elevated mortality rate. It is recommended that the procedures to be followed in the event of poisoning by the various plants and PTMP in question be evaluated and disseminated to practitioners. The prevention of these poisonings necessitates the implementation of an action plan, which should be incorporated into school curricula.

Limit of this Study

It is evident that the findings of this study are not representative of the Moroccan population, given that the sample under examination is confined to cases of plant poisoning and PTMP reported to the MPCPC. Nevertheless, the issue of under-

reporting remains a cause for concern for the MPCPC. A comprehensive study on the situation of poisonings linked to plant poisoning and PTMP in Morocco must be conducted. To this end, it is essential to engage the collaboration of all stakeholders in the health system in order to address the shortcomings of the current system.

Furthermore, the severity ranking provided by the MPCPC reflects the patient's condition at the time of peak effect. While this can provide an estimation of the true severity, it is not possible to assess cases where death has occurred. It is no longer possible to ascertain the admission grade of the deceased, as all cases were classified as grade 4.

Acknowledgements

We extend our gratitude to the Moroccan Poison Control and Pharmacovigilance Centre's management for granting us access to their database and to the staff for their support.

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