Species trade and conservation

Rhinoceroses

Assessment of Rhino Horn as a Traditional Medicine

A report prepared for the CITES Secretariat
by Kristin Nowell on behalf of TRAFFIC*

April 2012

Executive Summary

Pursuant to CITES Project No. S-389, the Secretariat concluded a contract with TRAFFIC in March 2012 to produce an overview report summarizing relevant information on the current usages of rhinoceros horn. This work was completed in April 2012 for consideration at the 62nd meeting of the Standing Committee (SC62). This report was supported by funding from DEFRA- Department for Environment, Food and Rural Affairs-UK.

This report is based on a literature review and information collected by non-governmental organizations (particularly TRAFFIC offices in East and Southeast Asia), and focuses on five historical consumer markets where both domestic and international trade in rhino horn is prohibited or controlled: China, Taiwan (Province of China), Japan, the Republic of Korea and Viet Nam. These five were selected based on a preliminary evaluation of available information as having strong traditions of medicinal use of rhino horn and varying experiences under existing rhino horn trade controls.

Structure and composition of rhino horn

Rhino horn grows in layers from specialized skin cells in layers, which are keratinized (invaded by keratin proteins) and become hard and inert, with all cellular function ceasing. Rhino horn lacks a bony core and is composed entirely of hard keratin proteins, of a type (the alpha keratins) common to most mammals. Rhino horn is similar, but not identical, in chemical composition to water buffalo, cattle and yak horns, which are frequently used to substitute for rhino horn in traditional medicinal formulas.

Although hard keratins are generally considered indigestible, being insoluble by human protein-digesting enzymes in the stomach, rhino horn and other animal horns are administered orally in powdered form in traditional medicine. Keratin supplements are also sold as “alternative” medicines (for different purposes than typically seen for rhino horn, e.g., to promote hair growth). Despite these types of medicinal use, keratin proteins do not appear to be seen by drug developers as having much therapeutic potential, as this literature review could find few examples of such research on keratin in general or animal horns in particular.

Scientific research on pharmacological effects of rhino horn

Rhino horn has not been well researched in comparison with other ingredients in traditional medicine. Only one study was found testing rhino horn for pharmacological effect in humans using the best-practice method of a randomized double-blind trial. That study found a short-lived significant effect on fever in children, but did not recommend its use as acetaminophen (a common nonsteroidal anti-inflammatory drug) performed better.

More testing has been done in the laboratory, using lab animals as well as *in vitro* techniques. Most of these studies have been done in China, where rhino horn is permitted to be used in research only to identify viable substitutes for it, and all found statistically significant pharmacological effects for rhino horn: anti-pyretic, anti-inflammatory, analgesic, procoagulant, among others. The same studies also found significant pharmacological effect for animal horn substitutes. In contrast, two studies done outside Asia (in the UK and South Africa) found no pharmacological effects at all for rhino horn or other animal horns; significant effect was found for some traditional medicinal plants tested which were being explored as potential substitutes for

* *The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat or the United Nations Environment Programme concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its author.*

rhino horn. A few different suggestions as to which components of rhino horn might be responsible for the observed pharmacological effects have been put forward, although the potential mechanisms of action were not elucidated.

Use of rhino horn as a traditional medicine

Use of rhino horn as an ingredient in medicine began in China several thousand years ago, and later spread to Japan, Korea and Viet Nam. Rhino horn is classified as a "heat-clearing" drug with detoxifying properties. It is generally used in combination with other medicinal ingredients, resulting in a wide range of conditions for which it has been traditionally indicated.

These conditions generally do not include cancer, although rhino horn is now being promoted by some as a cancer treatment in China and Viet Nam. Although classically traditional medicine did not have a diagnosis of cancer, it now does, and this review could find little evidence that rhino horn has been considered or studied as a potential treatment for cancer. There is more description in traditional medical literature of the use of rhino horn to treat stroke, but this literature review could find no clinical studies of it, although there has been substantial research effort on over 100 other traditional Chinese medicines for stroke (with inconclusive results).

Even as rhino horn appears to be gaining repute as an emergency drug for dire conditions, it is also being used in new ways more akin to recreation. In Viet Nam, rhino horn "has recently been used as a powerful aphrodisiac" according to a primary traditional medicinal text, but the most common usage, according to recent news reports and research undertaken by TRAFFIC, appears to be as a cleansing drink to soothe a hangover resulting from overconsumption of alcohol.

The factory production of medicines containing rhino horn appears to have ceased in the study locations, as manufacturers have complied with domestic trade bans, so that the main medicinal distribution channel today is probably as powder or chunks of horn for grinding at home, sold by traditional pharmacies that prepare prescriptions from dried ingredients. This distribution channel is difficult to monitor and detect illegal trade due to the large numbers of shops, clinics, hospitals, pharmacies, doctors and informal doctors.

Still, market surveys by non-governmental organization researchers posing as customers indicate that few are willing to engage in illegal trade; the most recent survey (2005-2006) of nearly 450 retail pharmacies across China found just 2% claiming to stock rhino horn. Time-lapse surveys indicate significantly reduced retail availability of rhino horn in several locations after major law enforcement and education and outreach activity. Although no such market surveys have been completed yet in Viet Nam, informal observation suggests relatively higher availability of rhino horn there, although much of it appears to be fake.

While fake rhino horn is fraudulent, there are numerous effective, viable and affordable substitutes for rhino horn in traditional medicine, the use of which has been encouraged by government and traditional medicine authorities, and surveys indicate that most practitioners are adopting them. Consumer attitudes toward rhino horn as a medicine have been little studied (although research is underway in Viet Nam). In Japan, only 17% of nearly 1,200 people surveyed had heard of rhino horn as a medicine, and just 1% said they had ever taken any.

There appears to be a growing market for rhino horn art carvings; over 190 advertisements for these were found over an eight-month weekly Chinese-language internet survey in 2005-2006. This demand may at least partly underlie a recent burst of robberies in Europe; since 2011, Europol reported 56 successful and 10 attempted thefts of rhino horns (from natural history museums and private collections) and especially rhino horn antiques.

Discussion

Rhino horn's long history of use in traditional medicine suggests that it has proved efficacious in the experience of many people, and some scientific research supports this, although negative results have also been reported. However, its medicinal use has been prohibited in the five countries/territories studied, and the traditional medicinal field has unquestionably made great advances without it over that period of time. A wide-ranging review found that most researchers in the field support application of the modern standards of evidence-based medicine to determine efficacy of traditional medical treatments. These standards have not been applied to rhino horn; without such scientific validation, any future legal use of rhino horn as a medicine to treat illness, and especially life-threatening ones, should be contemplated with caution.

Rarity underpins the value rhino horn is acquiring as a luxury item (art carvings, "rhino horn wine for millionaires" in Viet Nam), and probably also contributes to the elevated and unwarranted reputation of rhino horn as a miracle medicine that can work when others fail. Rarity would seem to be the main factor, more than any intrinsic value or properties of the horn itself, coupled with rising wealth in East and Southeast Asia,

which is inflating a bubble of demand for rhino horn. In formulating recommendations to enhance existing rhino horn trade controls, Parties may want to consider the legislative and policy, law enforcement, and demand deterrents that have been put forward to address illegal tiger bone trade, which like rhino horn is also prized in Asia for its historical medicinal reputation and current and illicit rarity.

Introduction

Pursuant to CITES Project No. S-389, the Secretariat concluded a contract with TRAFFIC in March 2012 to produce an overview report summarizing relevant information on the current usages of rhinoceros horn. This work was completed in April 2012 for consideration at the 62nd meeting of the Standing Committee (SC62). This report was supported by funding from DEFRA- Department for Environment, Food and Rural Affairs-UK.

"*Considerable concern was expressed over the plight of rhinoceroses*" at the 61st meeting of the CITES Standing Committee (SC61, Geneva, 2011), and "*several delegations voiced the need to work with traditional medicine associations and consumer States.*" The Standing Committee decided to establish an intersessional CITES Rhinoceros Working Group, chaired by the United Kingdom, and tasked it with identifying "measures that could be taken by CITES Parties to reduce the impact of illegal trade on the conservation of the rhinoceroses and to enhance existing controls on trade in rhinoceros horn products" (SC61 Summary Record p. 27).

Among other tasks, the Working Group was instructed to "collect and assess available scientific evidence and documented evidence of traditional cultural practices and beliefs that exist relating to the medicinal properties of rhinoceros horn, and in particular any which relate to the curative properties for cancer and strokes" (SC61 Summary Record, p. 28). In order to assist the Working Group, this report has been prepared by TRAFFIC for the CITES Secretariat, following the Terms of Reference of the contract, which called for TRAFFIC to collect and assess:

- available scientific evidence of traditional cultural practices and belief that exist relating to the medicinal properties of rhinoceros horn;
- available documented evidence of traditional cultural practices and beliefs that exist relating to the medicinal properties of rhinoceros horn;
- all available evidence with regard to traditional cultural practices and beliefs that exist relating to the medicinal properties of rhinoceros horn as a cure for cancers and strokes;
- all available evidence with regard to consumer attitudes towards rhino horn medicines;
- all available evidence with regard to forms in which rhino horn can be used (crushed, powdered, liquefied, soaked, mixed with other ingredients, etc.);
- all available evidence with regard to potential medicinal uses of horn from stuffed animals, hunting trophies, antiques, pre-Convention specimens and worked specimens; and
- all available evidence with regard to how widely rhino horn is used in traditional Asian medicine around the world.

This report is based on a literature review and information collected by non-governmental organizations (particularly TRAFFIC offices in East and Southeast Asia), and focuses on five historical consumer markets where both domestic and international trade in rhino horn is prohibited or controlled: China, Taiwan (Province of China), Japan, the Republic of Korea and Viet Nam (Table 1). These five countries/territories were selected based on a preliminary evaluation of available information as having strong traditions of medicinal use of rhino horn and varying experiences under existing rhino horn trade controls.

Table 1: Rhino horn trade bans in five selected study locations

Country or territory	Year international trade in rhino horn prohibited	Year domestic trade in rhino horn prohibited
China	1993*	1993
Taiwan (Province of China)	1985	1993*
Japan	1980	1995***
Republic of Korea	1983	1994
Viet Nam	1994	1994

* CITES entered into force in China in 1981, but export of manufactured medicines as pre-Convention rhino horn continued until 1993.

** Domestic legislation protecting CITES species enacted in 1989, but sale of stocks continued until 1993.

*** A notification was issued to delete rhino horn from medicinal prescriptions in 1980; domestic trade controls amended in 1995 to include rhinoceros horn and horn products (does not include derivatives not easily identified).

Sources: Mainka (1997); Mills (1997); Nowell *et al.,* (1992); Milliken *et al.,* (1994); Kang and Phipps, (2003); TRAFFIC East Asia *in litt*. 2012), Milliken *et al.,* (*in prep*.)

1. Rhino horn: structure and composition

Rhino horn is unique among ungulate horns (Modell, 1969), which are an extension of the skull with a substantial bony core and a thin outer sheath of hard keratin protein. The rhino's horn has no bony center; it is made up entirely of keratin, an epidermal derivative (grown from specialized skin cells), resembling the ungulate hoof and human fingernail. The horn is a fibrous composite, made up of elongated keratin tubules (averaging 100 nanometers in diameter, thicker than a horse's hoof but finer than a sheep's horn) embedded in an amorphous keratinous protein matrix, both having the same chemical composition (Hieronymus *et al.,* 2006; Figure 1). The fibrous structure of rhino horn can be used to distinguish pieces of rhino horn from other animal horns by microscopic examination (Zhou *et al.,* 2010). A rhino's horn regrows in periodic pulses from specialized epidermal cells at its base, but the cells which make up the horn are

Figure 1. Cross section of white rhino horn showing the matrix of keratin protein tubules (Hieronymus et al., 2006)

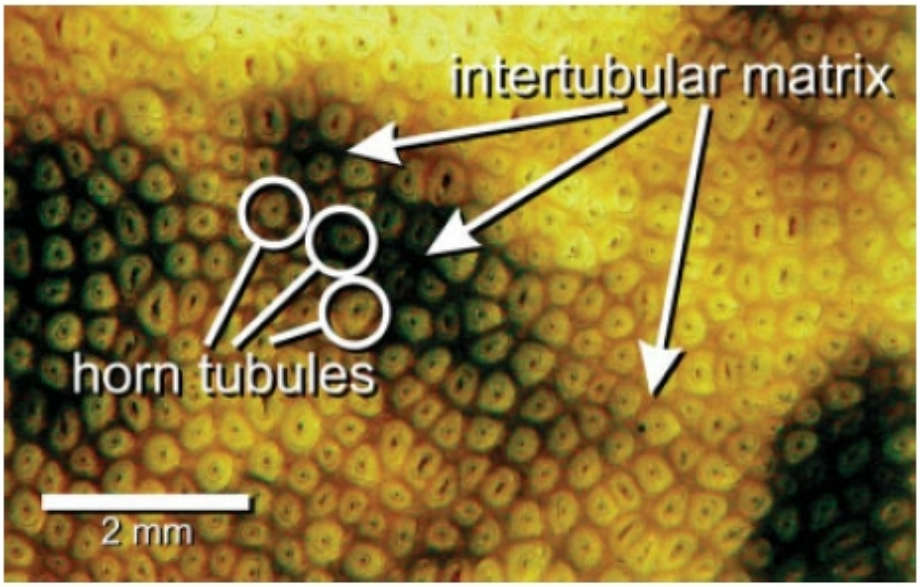
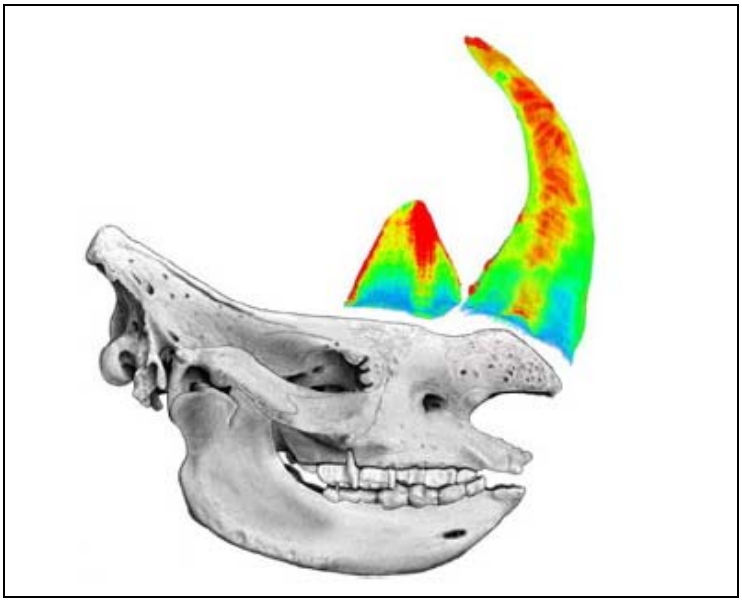


Fig. 2. *Ceratotherium simum*, OUVC 9541. Transmitted light view of a thick section (200 μm) of white rhinoceros horn from the center of a dark patch, showing areas of melanized intertubular matrix surrounding lighter horn tubules.

dead cells, having become inert and filled with keratin protein (Hieronymus *et al.,* 2006; Yang, 2011). Horns of African rhinos are estimated to grow approximately 5-6 cm in length annually, depending on rhino species, sex, age and other factors (Rachlow and Berger, 1997). The core of the horn is reinforced with deposits of calcium salts (for resistance to physical wear) and melanin (for resistance to UV light exposure) (Figure 2). The softer outer portion wears away with use and sun exposure, resulting in the sharpening of the inner core into the horn's characteristic curved and pointed shape (Hieronymus *et al.,* 2006). Noting the horn's strength, Yang (2011) suggested that if keratin could be engineered into a structure similar to rhino horn in the laboratory, it would be a great innovation in composites engineering.

Figure 2: CT scan showing horn density in a white rhino (Ceratotherium simum). Red areas show densest concentrations of melanin and calcium; blue areas are least dense (Yang, 2011, modified from Hieronymus et al., 2006)



The protective covering of all land vertebrates including skin, hair, feathers, claws, and beaks are formed from keratin. As the interface with the organism's changing environment, keratin proteins are highly heterogenous: keratin protein composition varies by species, and is most similar between closely related species (Butler *et al.,* 1990). Keratin is a mechanically durable and chemically unreactive protein, and rhino horn is entirely composed of hard alpha keratins, the type found in mammalian claws and hoofs (Yang, 2011), and consist of heptad repeats (imperfect repeats of 7 amino acid sequences). Rhino horn contains most of the common amino acids found in animal horn, in similar amounts. Lee and Kim (1974) reported that they found no significant differences between the relative composition of amino acids in rhino horn, water buffalo horn and cattle horn (with the exception of lysine, which was low in the latter) (Figure 3).

Figure 3: Table of amino acid components of rhino horn compared to cattle and water buffalo horn by researchers in the Republic of Korea (Lee and Kim, 1974)

동물 경조직 단백 성분의 조성과 생리기능에 관한 연구 129

TABLE Ⅱ: Amino Acid Composition of Animal Hard Tissue Proteins.
(g. of amino acid / 100g. protein)

Amino Acids	0.1M-Thioglycolate Protein Extract (at pH 12.3)		
	Bovine Horn	Water Buffalo Horn	Rhinoceros Horn
Tryptophane	0.65	0.75	0.65
Lysine	2.67	5.57	4.99
Histidine	0.86	1.12	1.21
Arginine	11.02	10.61	11.61
Aspartic acid	10.09	10.73	9.89
Threonine	3.98	3.97	3.90
Serine	4.50	5.16	4.48
Glutamic acid	18.62	19.36	18.24
Proline	3.74	2.87	3.16
Glycine	3.79	4.86	3.90
Alanine	4.50	4.44	5.27
Cystine	0.55	—	0.72
Valine	5.56	5.73	5.95
Methionine	0.68	1.26	0.90
Isoleucine	4.12	4.64	4.50
Leucine	10.23	10.96	11.23
Tyrosine	5.42	4.86	5.43
Phenylalanine	2.92	3.29	3.60
Carboxymethyl Cysteine	9.41	6.06	5.96
Total	103.41	106.27	105.09

Shigematsu *et al.* (1982) carried out a similar analysis and found that rhino horn and saiga antelope horn were very similar in their amino acid composition. They are not identical, however, and it is possible to distinguish rhino horn from other animal horns using non-native capillary isoelectric focusing (Huang and Yu, 1997) or infrared spectral analysis (Li *et al.,* 2011). Rhino and other animal horn keratins are held together by disulfide cross-linked bonds which "produce more rigidity in the structure and contribute to the insolubility of keratin".

In humans, proteins are usually digested for bodily absorption by enzymes in the stomach (pepsin) and small intestine (trypsin), but hard keratins are insoluble by these enzymes (Huang and Yu, 1997; Yamamura *et al*., 2002; Liu *et al.,* 2011; Yang, 2011). Some insects, microbes and fungi (such as *Tinea* which can infect human toenails, causing "athlete's foot") have specialized digestive enzymes known as keratinases which permit them to digest and utilize keratin, but not mammals (Yamamura *et al*., 2002; Gupta and Ramnani, 2006). That keratin resists digestion is indicated by the existence of another classic Chinese traditional medicinal ingredient, the ox bezoar (Niu Huang), a "hairball" or stony mass of undigested hair; bezoars can

also trouble people, particularly those afflicted with trichnophagia, the compulsive pulling and eating of one's own hair (Lynch *et al*., 2003). One study found that deer antler and saiga antelope horn were bioactive (able to regulate heat quantity change) in bacterial colony growth [*Escherichia coli*] after treatment with simulated gastric fluid (made up of hydrochloric acid, water and pepsin) (Yan *et al.,* 2010).

Keratin may be digested in the alkaline environment of the large intestine, as opposed to the acid environment of the stomach. Although other substances are now preferred, keratin was used from the late 1880s to the 1930s as an enteric coating for pills, meant to pass intact through the stomach and be absorbed more slowly in the intestine (Bukey and Rhodes, 1935; Wen and Park, 2010). Researchers have used strong alkaline reagents (typically urea) to isolate the protein components of rhino horn (Butler *et al.,* 1990; Huang and Yu, 1997; Liu *et al.,* 2011). Yet claws (and hairs) of prey animals pass intact through the intestines of predators, and are commonly retrieved from a wild predator's faeces to determine what it has eaten. It is possible that the traditional practice of grinding rhino horn into powder could aid its absorption in the body. Despite the seemingly indigestible quality of keratin, rhino and other animal horns are orally administered in traditional medicine. In addition, "alternative medicine" utilizes a number of herbal supplements in the form of pills and capsules that contain keratin, advertised variously as promoting hair growth, thickening hair, and easing painful joints

Rhino tissue (including the keratinized cells which make up the horn) also contain slightly varying forms or isotopes of common elements (such as carbon and nitrogen), as well as trace elements (such as strontium and lead) absorbed from the animal's diet. Patterns of abundance of these isotopes reflect their pattern of abundance in the vegetative environment, varying with geology, type of plant and climate. In Africa, these patterns, or "fingerprints," have been used to determine the species and geographical origin of rhino horns (Lee-Thorp *et al.,* 1994; Amin *et al.*, 2003). While these elements are valuable for a number of metabolic and nutritional needs, they are widely available to people in the diet and as supplements. Ge *et al.* (1997) found that rhino horn, water buffalo horn and cattle horn all contained comparable amounts of inorganic elements such as iron, zinc, calcium and magnesium.

2. Scientific research on pharmacological effects of rhino horn

While there has been a great deal of scientific research in recent decades aimed at developing modern drugs from traditional medicines, this literature review finds little evidence of such interest in keratin proteins in general or animal horns specifically, and thus cannot provide a context in which to consider the findings for rhino horn. There are a wide variety of protein-based medicines, used both as a preventative, the Hepatitis B vaccine being an example, and a treatment, as insulin is used for diabetes. Yet a review of over 130 protein therapeutics reveals no keratin-based developments (Leader *et al*., 2008). In cancer research, keratins are extensively used as diagnostic tumor markers, as epithelial malignancies largely maintain the specific keratin patterns associated with their respective cells of origin, and keratin proteins may even be involved in tumorigenesis (Karantza, 2010). Further specialist review may turn up more examples of clinical research into the therapeutic potential of hard alpha keratins, as some studies indicate that animal horns might have bioactive properties (Yan *et al.,* 2010; Luo *et al.,* 2011). However, outside the realm of traditional medicine, keratin treatments are most commonly encountered in beauty salons, as part of formulas marketed as agents for straightening and thickening hair.

The lack of clinical interest in horn derivatives stands in marked contrast to the attention paid to traditional plant-based medicines, some of which have proved spectacularly effective, such as the anti-malarial drug arteminisin, which was isolated in 1971 by Chinese scientists from the medicinal herb qinghao, or sweet wormwood (*Artemisia annua*) (Tu, 2011). Similar to rhino horn, qinghao was originally described in ancient Chinese texts as having heat-clearing and blood-cooling properties, and it was recommended for treatment of "intermittent fevers," a term which has since come to be used for malaria (Hsu, 2006). While its antipyretic and anti-inflammatory effects have been demonstrated in laboratory tests (Huang *et al.,* 1993), artemisin's main value is its ability to destroy malaria parasites, and its derivatives have become a major industry and the leading therapy (in combination) for *P. falciparum* malaria.

While sweet wormwood is an example of a traditional medicinal yielding compounds which have been deeply researched and analysed, in comparison rhino horn has generated few scientific investigations. This does not appear to be due to CITES and domestic trade controls, many of which were strengthened in the early 1990s, as testing appears also rather limited before that time. Most of the research conducted since was aimed not so much at developing useful new drugs from rhino horn, but rather to identify viable substitutes for a now-banned traditional remedy, comparing rhino horn effects to those of other common animal horns. Most of the research has been conducted in China, where government authorities have stated in a report to CITES that they require rhino horn to be "registered and sealed up (except for use on researches of substitutes since the national standard of using rhino horns in medicine was annulled in 1993" (Govt. of China, 2006).

2.1 Testing for effect on fever

Since the primary traditional medicinal value of rhino horn can be summarized as "removing heat" (discussed in more detail in section 3.1), most scientific research has focused on fever and rhino horn's ability to reduce it. This represents an unavoidable simplification of the primary property traditionally described for rhino horn. There are immense epistemological and ontological differences between the theories underlying traditional medicine vs. modern science (Shea, 2006). Several authors have reported that according to traditional diagnostics a patient suffering from a syndrome involving an excess of heat indicative of a prescription for rhino horn would not necessarily present an elevated temperature (But *et al*., 1991; Nowell *et al*., 1992; Bell and Simmonds, 2007). However, measuring effect on body temperature would appear to be a model acceptable to the traditional medicine community for testing rhino horn, as an extensive review of nearly 3,000 Chinese journal articles on efficacy trials of traditional medicines found that most have conformed to modern medical diagnostics and measurements, "often complemented by traditional Chinese methods" (Tang, 1999).

Unlike wormwood and its derivatives, which have been extensively studied in humans, as would be expected for a human medicine to be found safe and approved or recommended, this literature review could identify only one scientific evaluation of rhino horn's effect on human fever according to modern clinical standards (Tsai 1995). Antipyretic function of rhino horn was tested in a double-blind study, which is the best practice in eliminating bias in experiments involving humans, in which neither the subjects nor the researchers know who belongs to the control group and the experimental group. The research was done in Taiwan (Province of China) in 1993 in order to recommend substitutes (Tsai, 1995). The study, conducted in a hospital setting,

Table 2: Results obtained for rhino horn in the only double-blind study of its ability to reduce fever in humans (Tsai, 1995)

	Rhino horn	Buffalo horn	Placebo	Acetaminophen
Number of children	42	30	26	44
Average age (months)	24.3 ± 25.2	21.6 ± 28.5	19.0 ± 19.2	18.1 ±12.5
Body temperature average reduction from start (deg C)*				
15 minutes	-0.5 ± 0.6[a]	-0.3 ± 0.5	0.0 ± [0.]5[a,b]	-0.6 ± 0.3[b]
30 minutes	-0.4 ± 0.7	-0.3 ± 0.4[c]	-0.1 ± 0.4[d]	-0.7 ± 0.5[c,d]
45 minutes	-0.4 ± 0.6[e]	-0.2 ± 0.5[f]	-0.2 ± 0.4[g]	-1.1 ± 0.8[e,f,g]

*The small letters refer to comparisons found to be statistically significant (P<0.05). For example, "a" in the 15 minute row indicates that rhino horn was significantly different from the placebo, as was acetaminophen. In the 45 minute row, the "e" shows that temperature difference obtained from acetaminophen differed significantly from rhino horn. The same was true for water buffalo horn (f) and the placebo (g).

focused on 142 young children, ranging in age from 3 to 114 months and averaging 20 months, suffering some form of infection and presenting with fever (average 39.2°C) but excluded cases that required steroids, antibiotics, immune-suppressants or anti-cancer therapy. The children were given, by oral administration with water, powdered rhino horn (0.05 g/kg), water buffalo horn, a placebo (starch) or a non-steroidal anti-inflammatory drug (NSAID) (acetaminophen). Body temperature was measured from ear temperature 15, 30 and 45 minutes after the dose. Patients with temperatures remaining above 38.5°C after this time were given a follow up course of aspirin.

While patients receiving rhino horn recorded a statistically significant reduction of 0.5°C after the first 15 minutes, the reduction stopped after that and ended at a 0.4°C reduction (Table 2). The acetaminophen performed best and was recommended by the study's authors, with statistically lower temperatures than the placebo achieved at each of the time intervals and the biggest average reduction in temperature at the end of the study (1.1°C). It should be noted that 57% of the children given rhino horn ended with temperatures lower than 38.5°C, so that the follow-up course of aspirin was not necessary. In this sense, performance was comparable to acetaminophen (63.6%). However, the study concluded "since the Rhino is going to extinction and antipyretic efficacy of rhino horn is less effective than acetaminophen, rhino horn is NOT recommended for isolated use in febrile children" (Tsai, 1995).

Seven studies testing rhino horn's effect on fever in laboratory animals were identified and obtained by this review (summarized in Table 3). Six of the tests found that rhino horn reduced fever, sometimes at higher than human dosage, while one did not. Six of the tests also found that horn substitutes also reduced fever, and two out of three found that NSAIDs outperformed rhino horn. While these studies used similar methods and similar dosages, including the reported human dose of approximately 0.05 grams/kg of rhino horn (But *et al.,* 1990; Tsai, 1995; Liu *et al.,* 2011), there were some methodological differences which could explain why

the one study conducted outside China (Laburn and Mitchell, 1997) could not replicate the finding of anti-pyretic function (Table 3).

Mixed results were also reported by authors who reviewed earlier studies of fever-induced rabbits. But *et al.* (1990) reported that oral administration failed to achieve antipyretic effect in one study (Huang *et al.,* 1959), while intravenous injection of rhino horn in aqueous solution was found to relieve fever in another study by Ogata *et al.*

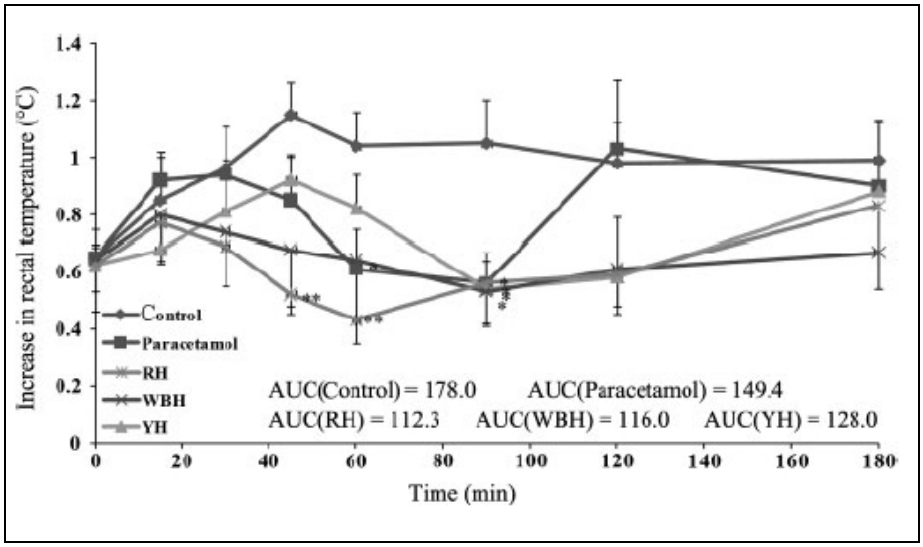
Rhino horn dosage (g/kg) (human dosage = 0.05 g/kg)	Significant fever reduction at human dose?	Significant fever reduction at higher dosage?	Significant fever reduction with horn substitute?	NSAID performed better than rhino horn?	Test animals (n)	Hyperthermia induction method	Rhino horn form	Delivery (humans = oral)	Body temperature monitoring period	Reference
0.06 g	Yes	n/a	Yes	No	Rabbit (12)	Bacterial endotoxin (IV injection of E.coli at 20 ng/kg)	Powder	Oral (60 min after endotoxin injection)	3 hours	Liu *et al.,* (2011)
0.05 and 0.5 g	No	No	No	Yes	Rabbit (7)	Bacterial endotoxin (IV injection of Salmonella typhosa at 0.1ng/kg (2 ml))	Liquid (boiled horn powder with water to concentrations of 20 and 200 mg horn/mil water)	Intragastric catheter (administration simultaneous with endotoxin injection)	4 hours	Laburn and Mitchell, (1997)
0.5, 1, 2.5 and 5 g	n/a	Yes	Yes	n/a	Rat (10)	Chemical pyrogen (Subcutaneous injection of turpentine oil at 0.4ml/kg)	Liquid (boiled horn powder with water to concentrations of 0.5, 1, 2.5 and 5 g horn/ml water)	Injection (two IP injections 9 and 12-13 hours after turpentine injection)	6 hours	But *et al.,* (1990)
0.5 and 2.5 g	n/a	Yes	Yes	n/a	Rat (10)	Chemical pyrogen (Subcutaneous injection of turpentine oil at 0.4ml/kg)	Liquid (boiled horn powder with water to concentrations of 2.5 and 0.5 g/ml. Tested alone as well as with herbs in a classical prescription	Injection (two IP injections 9 and 12-13 hours after turpentine injection)	6 hours	But *et al.,* (1991)
0.05, 0.1 and 0.2 g	No	Yes	Yes	Yes	Rabbit	Bacterial endotoxin (IV injection)	Liquid (ground rhino horn powder diluted with 0.5% of Carboxymethyl cellulose to suspension liquid)	Intragastric catheter (one hour before endotoxin injection)	5 hours	Song *et al.,* (2010)
3 and 9 g	No	Yes	Yes	n/a	Rabbit (45)	IV injection (outdated whooping cough and tetanus) vaccine (2ml), diluted with Normal saline to 0.1ml/ml)	Liquid (diluted to 0.9 g/ml)	Intragastric catheter (one hour after fever induced)	4 hours	Shen *et al.,* (2010)

Table 3: Comparison of methods and results from scientific studies in laboratory animals of fever-reducing property of rhino horn

(1960). As reviewed by TRAFFIC (1998), researchers in Japan in the 1980s found no antipyretic effect in rabbits, with fever induced by three methods, including a bacterial endotoxin as used by other studies. World Wildlife Fund reported that the Hoffmann LaRoche pharmaceutical corporation did not find any antipyretic effect in rhino horn in tests which it requested (Anon. 1983); this result has been widely reported although the full study was never made available.

Table 3 shows that only one study (Liu *et al.,* 2011) found that rhino horn significantly reduced fever in lab animals at the human dosage. Liu *et al.* (2011) found that body temperature in rabbits given saline increased by more than one degree Celsuis and held steady for 180 minutes (shown in the top line in the graph of Figure 4), while in comparison rabbits given rhino horn showed a significantly lower temperature increase in the first 100 minutes (the bottom line in the graph of Figure 4). Unlike the study of children (Table 2), they found that rhino horn performed better than acetaminophen (Paracetamol in Figure 4).

Figure 4: Liu et al. (2011) find that rhino horn significantly reduced endotoxin-induced fever in rabbits



RH=Rhino Horn; WBH=Water Buffalo Horn; YH=Yak Horn. AUC=Area Under Curve (single value for area under each substance's time line). Significant difference from control: ** p<0.01; * p<0.05

In contrast, Laburn and Mitchell (1997) found no antipyretic effect at all for rhino horn or a horn substitute, only indomethacin, a common NSAID, significantly reduced fever (Figure 5). They alone among the researchers also carried out an experiment on afebrile animals, in which rabbits were injected with saline water rather than a bacterial

Figure 5: Laburn and Mitchell (2007) did not find any antipyretic effect of rhino horn for endotoxin-induced fever in rabbits (*LPS = bacterial endotoxin pyrogen)

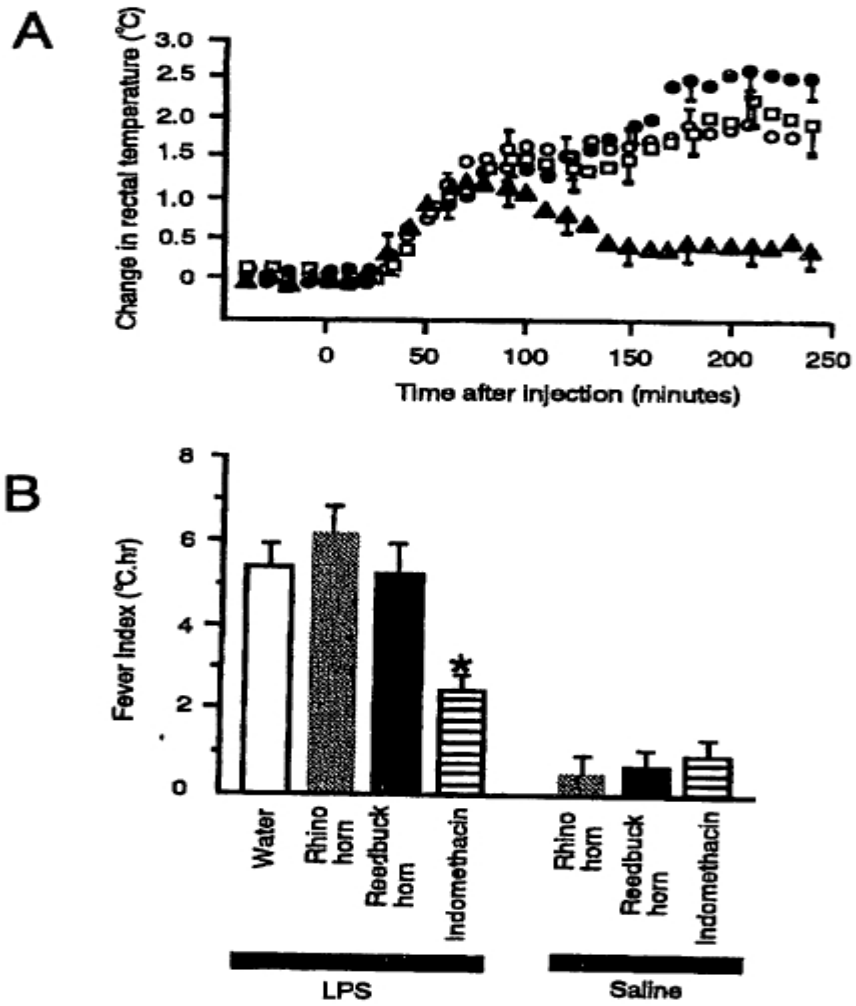


Fig. 2: **A:** Changes in rectal temperature of rabbits after intravenous injection of LPS (0.1 μg/kg) together with an intragastric administration of boiled water (O), 500 mg/kg rhinoceros horn extract (●), 500 mg/kg reedbuck horn extract (□) or 10 mg/kg indomethacin (▲). Other details as in Figure 1. **B:** Four-hour fever indices (in °C.hr) for the responses shown in A, and when sterile saline was substituted for the LPS solution, showing the effect of horn extracts on afebrile animals. The four-hour fever index following LPS injection and intragastric indomethacin administration was significantly lower than that which followed LPS injection and water administration ($P<0.05$, t-test). Fever indices for administration of horn extracts or indomethacin after saline injection did not differ significantly from zero.

Several studies found that rhino horn at higher than human dosages significantly reduced fever (But *et al.,* 1990, 1991; Song *et al.,* 2010). Song *et al.* (2010) found that rhino horn at a dose of 0.2 g/kg resulted in significantly lower body temperature rise, almost equivalent to aspirin; a lower dose (0.1 g/kg) was less effective and the human dosage (0.05 g/kg) did not reduce fever (Table 4). But *et al.* (1990, 1991), using a different fever induction method, found reduced temperatures only with higher than human dosages (0.1 g/kg in combination with herbs, and alone at 1-5 g/kg).

Table 4: Song et al. (2010) find significant fever reduction in endotoxin fever-induced rabbits given rhino horn, but only at doses higher than that normally taken by humans

Groups	Dosage (g/kg)	Rabbit (n)	Temp before medicine (°C)	Temp increase (°C)
Model		12	39.26 ± 0.18	3.54 ± 1.06
Aspirin	0.1	10	39.26 ± 0.20	1.65 ± 1.18*
Rhino horn	0.2	10	39.18 ± 0.22	1.85 ± 1.86*
Rhino horn	0.1	10	39.05 ± 0.18	2.38 ± 0.98+
Rhino horn	0.05**	10	38.85 ± 0.32	3.57 ± 1.28

Comparison with model group: + P<0.05, * P< 0.01 **Human dose

All of the studies which found that rhino horn had some antipyretic value also found that common animal horn substitutes had an equivalent fever-reducing property (Table 3). Laburn and Mitchell (1997), in contrast, found no fever reduction for reedbuck horn.

2.2 Testing for other pharmacological effects

Five studies testing rhino horn for other pharmacological effects were identified and obtained by this review. The pattern of results is similar to the fever research, with four out of five studies finding positive results (Table 5). There were methodological differences: the study which produced negative results used *in vitro* rather than *in vivo* models.

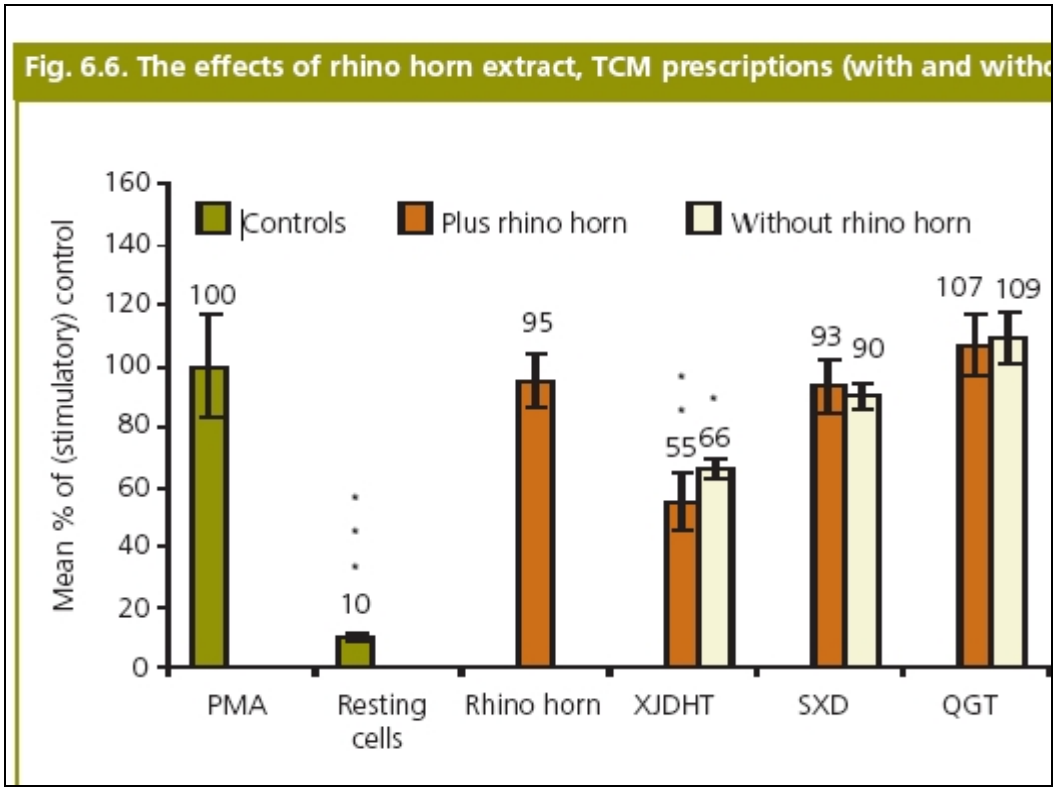
Rhino horn was tested for anti-inflammatory properties *in vitro* by Bell and Simmonds (2007). Rhino horn (with a 100 ng/ml in aqueous solution), alone and in combination with other classically prescribed herbs, was tested for effect on nuclear factor kappa B (NF-κB), an anti-inflammatory mediator. Rhino horn alone did not show any inflammation-inhibiting effect on PMA-stimulated stem cells. Significant inhibition was obtained only with one of five tested herbal combinations, both with and without rhino horn (Xijiao Dihua Tang, XJDT in Figure 5), leading the researchers to conclude that

Table 5: Results of scientific research on other pharmacological properties of rhino horn

Property investigated	**Rhino horn significant effect?**	**Rhino horn substitute significant effect?**	**Performed better than Western medicine?**	**References**
Analgesic	Yes	n/a	No	Song *et al.,* (2010)
Antibacterial	No	Yes	n/a	Bell and Simmonds, (2007)
Sedative	Yes	Yes	No	Liu *et al.,* (2011)
Anti-hemorrhagic	Yes	Yes	No	Liu *et al.,* (2011)
	Yes*	n/a	n/a	Park and Kim, (1991)
Anti-inflammatory	Yes	n/a	No	Song *et al.,* (2010)
	No	Yes	n/a	Bell and Simmonds, (2007)
	Yes	n/a	n/a	Feng *et al., (*2006)

*Rhino horn was used in combination with other herbs, and not tested alone

Figure 6. The anti-inflammatory effect of rhino horn extract in TCM prescriptions on PMA-irritated stem cells; one mixture of herbs was significant (XJDHT, marked with asterisks) with and without rhino horn (Bell and Simmonds, 2007)



"further work is required to clarify the contribution of the [rhino] horn extract and whether there is a synergistic effect." Much stronger inhibitory effect was demonstrated in a number of herbal substitutes also tested by Bell and Simmonds (2007).

However, Song *et al.* (2010), using standard *in vivo* mice models (albumin-induced metatarsal swelling, xylene-induced ear edema, cotton pellet granuloma), did find a significant anti-inflammatory effect of rhino horn (Table 6). Feng *et al.* (2006) also found that rhino horn, in combination with the herb *Rehmannia*, significantly reduced local swelling in human victims of poisonous snakebite, when added to a standard treatment regimen including antivenin and antibiotics.

Table 6: Rhino horn anti-inflammatory effect for cotton ball-induced granuloma and xylene-induced ear selling on mice (Song et al., 2010)

Groups	Dosage (mg/kg)	Granuloma		Ear swelling	
		No. of mice	WT (mg)	No. of mice	Ear WT difference (mg)
Model		10	10.9 ± 3.78	10	7.30 ± 3.71
Aspirin	0.2	10	6.00 ± 2.44 **	10	2.70 ± 1.83 **
Rhino horn	1.4	10	7.35 ± 2.79 *	10	2.75 ± 1.44 **
Rhino horn	0.7	10	6.80 ± 3.68 *	10	3.70 ± 2.50
Rhino horn	0.35	11	10.09 ± 3.73	10	4.20 ± 2.44

Statistical significance of result: * P<0.05, ** P< 0.01 (strongest)

In addition to anti-inflammatory effects, other potential pharmacologic effects of rhino horn have also been investigated. An analgesic (pain-relieving) effect was found in mice injected with acetic acid (as measured by

decrease in their writhing movement) (Song *et al.,* 2010). Liu *et al.* (2011) found rhino horn to have a sedative effect when orally administered to mice at 0.22 grams/kg, as measured by reduction of spontaneous activity in mice after 30 minutes (Liu *et al.,* 2011). However, they also found that yak and water buffalo horn had a significant effect, and that the strongest effect was observed with the synthetic drug enzolam. Bell and Simmonds (2007) found that rhino horn had no ability to inhibit bacterial growth (*B. subtilis* and *P. syringae*). Park and Kim (1991) reported significant effects of rhino horn as a blood clotting agent in rats, used in combination with other herbs in classical prescriptions, and Liu *et al.* (2011) also reported that rhino horn alone resulted in a significant reduction in coagulation time in mice. They also found a significant procoagulant effect for the other substances tested – yak horn, water buffalo horn and aminoethylbenzoic acic (a common anti-hemorrhagic). It is also notable that another study found that water buffalo horn had the opposite, anti-coagulant effect (Luo *et al.,* 2011). A cardiotonic effect was reported from Japanese research on toad hearts, as well as the ability of rhino horn to affect blood pressure in rabbits, an effect they attributed to thiolactic acid (TRAFFIC, 1998), but as the source is secondary these effects are not included in Table 5.

2.3 Testing for active components

The literature review found few attempts to identify the components of rhino horn that might be responsible for the pharmacologic effects identified in some of the scientific studies above. Patton (2011) reported that the chemical compound associated with rhino horn in the second edition of *Traditional Chinese medicines: molecular structures, natural sources and applications* is ethanolamine, which had been previously identified by studies as a phosphorous-linked constituent of rhino horn (But *et al.,* 1990, Li *et al.,* 2011). Patton (2011) notes that ethanolamine oleate is used in human medicine to reduce esophageal bleeding; it is also used as a sclerotic injection to treat varicose veins. A drug database maintained by Kyoto University in Japan (the KEGG Drug Database at www.genome.jp) still lists rhino horn as a crude (natural) drug, and identifies the active components as tyrosine, cystine and thiolactic acid. Neither of these sources specify how the active components were determined and tested.

Wang *et al.* (2007) used High-Performance Liquid Chromatography (HPLC) to analyse aminoethylsulfonic acid (taurine) and cholesterol, and spectrophotometry to analyse aminohexase and free protein in rhino, saiga and six other medicinal animal horns. Based on their results, the authors suggested that taurine might be one of the active substances. Taurine is found throughout the body, particularly in the skeletal muscles, and sees its widest use as an ingredient in energy drinks.

The literature review found only one study (Liu *et al.*, 2011) designed to correlate pharmacologic effect with the primary constituents of rhino horn, keratin proteins (reviewed in Table 3, where it was the only study to find an antipyretic effect of rhino horn at the normal human dosage). Noting that keratin proteins can only be dissolved for analysis using harsh chemical extraction or enzymolysis methods, they solubilized proteins from rhino and other bovine horns with a lysis (urea) buffer and used two dimensional electrophoresis (2DE). This process involves application of an electrical field to separate proteins by charge and/or mass into their constituent peptide fragments (sequences of up to 50 amino acids). They found 14 common peptides in rhino, water buffalo and yak horn. Using linear regression analysis they found the best fit between peptide abundance in the horn samples and the value for observed pharmacologic effect (antipyretic [i.e., the AUC values shown in Figure 4], sedative, procoagulant) for five peptides, with significant correlation for the same peptides for all three types of horn tested. They suggested that these five peptides were likely to be the

active components in the horns (Table 7), although they did not examine how they would be likely to have the correlated effect.

Table 7. Peptides (protein fragments) in rhino horn correlated with therapeutic effect by Liu et al. (2011). Three could not be matched to a major peptide database; the first was identified as a transcription factor; and the fourth as belonging to a bacterial pathogen of ruminants.

Table 2. Identification of proteins isolated from horns by PMF analysis

Spot no.	Matched proteins	Accession no.	Theoretical kDa/p/	Matched peptides	Sequence coverage (%)
6	Zinc finger CCCH-type containing 12D	CAX11887	12 433/8.01	8	86
7	No match	–	–	–	–
10	No match	–	–	–	–
11	Peptide methionine sulfoxide reductase	YP_001256455	35 800/6.01	15	60
14	No match	–	–	–	–

When compared to a major protein database, two of these five were identified and three were unknown, with the authors suggesting they might be further identified through tandem mass spectrometry. One of the identified peptides (spot 11, peptide methionine sulfoxide reductase) was identified as belonging to *Mycoplasma agalactae* (strain PG2), which is primarily known as a major bacterial pathogen of small livestock, causing death from contagious agalactia affecting the eyes, joints and udder. It was found in all three horns, and it is unclear whether the authors consider this peptide to be a horn constituent or if all three horns were carrying the pathogen, as they do not comment on its presence beyond reporting it. The other identified peptide is a type of zinc finger, a transcription factor (one of the groups of proteins found in organisms ranging from yeast to humans that read and interpret the genetic "blueprint" in DNA). Zinc fingers appear in the scientific literature primarily in the field of gene therapy, as they can carry therapeutic genes to specific chromosomal sites.

3. Use of rhino horn in traditional medicine

Use of rhino horn as an ingredient in medicine began in China several thousand years ago, in 2600 BC, according to the earliest written record, the *Shen Nong Ben Cao Jing* or Divine Peasants Herbal from the Han Dynasty (206 BC to AD 220). Medicinal practices from China spread throughout Asia and were adopted, with modifications by other cultures. In Japan and the Republic of Korea, the terms for traditional medicine translate literally as “Chinese medicine,” while Vietnamese call Chinese medicine “Northern medicine” and their own system as “Southern medicine.” Asian rhino horn was traditionally used, but as African horn became available in more recent times it was also utilized, although it was distinguished from Asian horn by various names and sold at a lower price, with Asian horn perceived as being of higher quality (Nowell *et al*., 1992) but also possibly due to the relative rarity of Asian rhinos (Milliken *et al*., 1994).

While this review covers description of rhino horn in numerous traditional medicine texts, both historical and modern, it is important to note that use of rhino horn as a medicinal ingredient is prohibited not only in the five locations studied (Table 1), but also most places where Chinese-based traditional medicine is practiced by the diaspora (Mainka, 1997).

3.1. Traditional cultural practices and beliefs

The first description of rhino horn from the Han dynasty's Divine Peasant's Herbal noted rhino horn's "chilling" and "detoxifying" properties. While TCM theory and practice has evolved since then, these properties have generally held constant through time (Table 8).

An example of the constants in the reference to and use of rhino horn is the President of the U.K. Association of Traditional Chinese Medicine identifying the main use of rhino horn in treating "heat toxin in the blood" syndrome. It is important to note that he added that although there was no equivalent in modern medicine, serious infection was generally involved, and that cheaper and more effective alternatives were used today: "Normally, we use antibiotics" (Graham-Rowe 2012). In Viet Nam, one doctor explained that because rhino horn has cooling abilities, with bitter, acidic and salty properties, these attributes reportedly make rhino horn effective in reducing temperature, especially internal heat in the blood, and purging the body of toxins (Milliken *et al*., in prep).

Table 8: Examples of descriptions of rhino horn medicinal properties and applications from ancient to modern times in Chinese literature

Year	Description	Source
200 BC-200 AD	Of bitter taste, sour, salty, chilling, non-poisonous, and can dominate over hundreds of toxic substances. It can detoxify the poison of an insect sting, toxic feather or snake bite, and can keep away evil. If taken for a long period of time, the patient will feel relaxed and light.	*Divine Peasants Herbal*. Han dynasty (from Nowell *et al.,* 1992)
1757	Rhino horn can cool down the heart, release waste from the liver, clean the stomach, reduce fever, remove the cold, clear the windpipe, keep away evil, detoxify poisons, cure typhoid and epidemic diseases, as well as cure symptoms such as jaundice, rashes, vomiting blood, excreting blood, delirium, abscesses and lumps etc. It can also soothe the patient's nerves and improve his eyesight.	New Compilation of Materia Medica (Ben Cao Zong Shin) (from Nowell *et al.,* 1992)
1987	Rhino horn has a sour and salty taste and a "cold" property. The horn is credited with latent-heat-clearing, antipyretic, detoxicant, anti-inflammatory, and anticonvulsant activities as well as the ability to remove pathogenic "heat" from the blood. It is administered in coma and delirium of febrile diseases, erythema, hematemesis and epistaxis.	W. Yuan in Chang H-M. and But P-P-H., 1987. Pharmacology and Applications of Chinese Materia Medica. Vol II.
1990	Used for: removing heat from the blood, inducing hemostasis, clearing away heart-fire to achieve tranquilization of the mind, removing toxic substances and relieving feverish rashes or eruptions.	Zhang, E. The Chinese materia medica. Shanghai College of Traditional Medicine. In Mills, 1997.
1994	Strong action of clearing heat, removing heat from the blood, and arresting convulsions	Xu X. (ed.) The English-Chinese Encyclopedia of Practical Traditional Medicine (in Bell and Simmonds, 2007)
2003	Rhino horn is cold in nature and bitter and salty in flavor. It primarily clears construction and cools the blood, and also resolves toxin and stabilizes fright.	*Ten lectures on the use of medicinals by the personal experience of Jiao Shude.*
2003	Effects: to cool blood, clear heat, resolve toxin, settle fright. Indications: blood ejection, spontaneous external bleeding, acute febrile disease, epidemic febrile diseases.	Traditional Chinese medicines: molecular structure, natural sources and applications. In Patton, 2011.
2012	Xi Jiao (rhino horn): Cools Blood; Stops bleeding; Disperses Fire; Expels toxins; Calms the Mind; Calms sudden fright.	TCM Assistant, online Chinese herbal medicine database
2012	Xi Jiao (rhino horn): Cold, bitter, salty. Primary action: cools blood. Secondary actions: Clear heat toxins; Drain fire; Extinguish wind; Stop spasm.	Chinese Herb Academy online database

Modern texts (generally before the prohibition of its use in traditional medicine) from China (Table 8), Japan (T. Milliken, *in litt*., 2012), the Republic of Korea and Viet Nam classify rhino horn as a “heat-clearing” drug, although one Vietnamese text warns that it should not be used by people with a “not-high fever.” (Do *et al*., 2006). In the Republic of Korea, rhino horn “is used to treat warm-febrile disease and for very high fever”

(Lee, 1995). This does not restrict rhino horn's use to fevers, although modern texts tend to include "antipyretic" along with heat-clearing. In traditional medicine, syndromes involving an excess of heat do not always manifest in elevated body temperature and can result in a variety of symptoms (But *et al.,* 1990; Nowell *et al.,* 1992; Bell and Simmonds, 2007). Thus, rhino horn has been used to treat a variety of different illnesses in addition to fever.

In traditional medicine rhino horn is never prescribed alone, which further complicates a complete description of its traditional medicinal properties. For example, the main medicine containing rhino horn sold in the Republic of Korea prior to the prohibition of domestic trade in 1994, Chung Shim Wan medicine balls, contained a total of 30 ingredients (Table 9). Combinations of rhino horn with other herbal and animal ingredients results in an expanded view of the conditions it can be prescribed for. For example, TRAFFIC research identified 73 different manufactured medicines (mainly for detoxification) which used to contain rhino horn but are now produced without it (Joyce Wu, *in litt*., 2012). Thirty-one manufactured medicines labeled as containing rhino horn among the ingredients, all produced in China, were found in a TRAFFIC database of over 600 manufactured medicines, catalogued in the United States from market surveys, interviews with traditional doctors, government seizures and literature review, (Gaski and Johnson, 1994). Sixteen different medicines containing rhino horn were identified from texts in the Republic of Korea; Table 10 shows the wide variety of ailments for which they would be used. The Viet Nam Oriental Traditional Medicine Association recently reported that four medicinal products including rhino horn are used in Viet Nam, including Công Thûc (to reduce temperature in the heart), An Công Nguu Hoàng Hoàn (for treatment of stroke and blockage of blood in the brain), Cuc Phuong Chi Bào Don (for treatment of "evil wind" conditions such as dizziness or faintness, loss of consciousness or the power of speech, breathing difficulties and blood clots in the brain), and Nguu Hoàng Thanh Tâm Hoàn (for treatment of myocardic problems, high fever and convulsion) (Milliken *et al*., in prep).

Table 9: Ingredients in Chung Shim Won balls, formerly the main manufactured medicine containing rhino horn in the Republic of Korea (Song and Milliken, 1990)

Table IV
Prescription for Chung Shim Won Balls

English or Common Name	Scientific or Pharmaceutical Name	Amount
Chinese Yam Root	*Dioscorea Batatas*	28.0 g
Licorice Root	*Glycyrrhiza uralensis*	20.0 g
Ginseng Root	*Panax ginseng*	20.0 g
Cattail Polen	*Typha spp.*	10.0 g
Medicated Leaven	*Massa Fermentia*	8.0g
Rhinoceros Horn	Rhinocerotidae spp.	8.0g
Young Soybean Sprout	Glycine mas	8.0g
Saigon Cinnamon Twigs	*Cinnamomum cassia*	6.8 g
Donkey skin Gel	*Colla asini*	6.8g
Peony Root	*Paeonia lactiflora*	6.8 g
Lush Winter Wheat	*Ophiopogon japonicus*	6.8g
Baical Skullcap Root	*Scutellaria baicalensis*	6.8g
Tangkuei Root	*Angelica sinensis*	6.8 g
"Guard against Wind"	*Ledebouriella sesloides*	6.8g
Cinnebar	*Cinnabaris*	6.8 g
	Atractylodes macrocephala	6.0 g
Hare's Ear Root	*Bupleurum scorzoneraefolium*	6.0 g
Balloon Flower Root	*Platycodon grandiflorum*	6.0 g
Almond Kernal	*Prunus armeniaca*	6.0 g
Sclerotium of Tuchkahoe, China-root	*Poria cocos*	6.0 g
Szechuan Lovage Root	*Ligusticum wallichii*	5.0 g
Cow or Water Buffalo Bezoar or Gallstone	*Bos taurus domesticus*	5.0g
Saiga Antelope Horn	*Saiga tatarica*	5.0g
Musk	*Muscus spp.*	5.0g
Processed Resin of Borneol Camphor	*Dryobalanops aromatica*	4.0g
Realgar	Realgar	4.0 g
	Ampelopsis japonica	4.0 g
Dry Ginger	*Curcuma zedoaria*	3.0 g
Jujube Fruit	*Ziziphus jujuba*	20 pc
Gold paper		

Source: *Pang Yak Hap Pyun* (Korean Medicine Prescription Book)

Table 10: 16 prescriptions for rhino horn in the traditional literature of the Republic of Korea (Song and Milliken, 1990)

Table III
Korean Herbal Medicines which contain Rhino Horn

Name	Use	Number of ingredients	Amount of Rhino Horn
Sogaktaechongtang	Rashes	9	5.62g
Shihosogaktang	Mental disorders	6	3.75 g
Hwanchonghwang	All kinds of eye diseases	29	30.00 g
Sonbanghwalmyongum	Stomach ulcers	10	3.75 g
Yongyanggaksan	Children's fits	11	26.25g
Kamikilgyongtang	Blistered lips caused by rashes on the face.	12	3.75 g
Uhwangchongshimwon	Strokes. Loss of consciousness, excessive phlegm and saliva constricting the throat, dizziness, trouble with speech. Also for troubles with mouth, eyes, and use of hands and feet. Fever in the back or the heart. Urination during sleep, high blood pressure, mental unrest, hysterics, insomnia and mental disorders.	30	8.00 g
Sogaksoonmatang	Paralysis, pain in area between the nose and the forehead, mouth mobility dysfunctions, paleness in the upper part of the cheeks. Also for fever inside and outside body (sic), and swollen gums and face accompanied by pain. Erysipelas.	9	6.00 g
Kumichongshimwon	Fever and diseases of the heart	9	80.00 g
Chongshimkontamhwang	Epilepsy and general treatment for all kinds of strange diseases. Eliminates fever when it effects secretions inside the body.	8	20.00 g
Yongnoianshinhwang	Five kinds of epilepsy both acute and chronic. Eliminates fever after smallpox.	13	40.00 g
Sogakchihwangtang	Nosebleeding and when dried blood remains in the vital organs or when the face becomes blackish.	4	4.00 g
Sohapyyangwon	General treatment for all kinds of diseases. Also for delerium.	15	80.00 g
Hwangryontang	Swelling of the tongue, when the body is dry and feverish and needs moisture owing to fever in the heart; or when the tip of the tongue is bleeding and stiff.	9	2.00 g
Soongmahwangryontang	Feverish face	10	1.00 g or 2.00 g
Sogaksodokum	Erysipelas, smallpox and nettle rash	5	6.00 g

Sources: Dung *Maek Pang Yak Pyun* (Korean Medicine Prescription Book), Won Shik Bae (ed.), 1987*Jea Shin Pang Yak Hap Pyun* (Korean Medicine Prescription Book), Ui Kun Kim (ed.), 1976

The dosage recommended in available literature also varied considerably, again creating confusion on the properties of rhino horn. In Viet Nam, the daily dosage is 0.5-1 grams, sometimes 3-4 grams (Do *et al*., 2006). In Taiwan (Province of China), pharmacists reported an average dosage of approximately two grams (Nowell *et al*., 1992). Dosage was reported by But (1990) and Liu *et al*. (2011) at 0.5-0.6 grams/kg body weight, suggesting approximately 3 grams for a 60 kg adult. In the Republic of Korea, the amount of rhino horn in manufactured medicines varied widely (Table 10).

Combination with other ingredients results in a wide array of conditions which traditional medicine practitioners consider to be treatable with rhino horn. For example, forty-one doctors surveyed in Taiwan (Province of China), by TRAFFIC researchers in cooperation with the Society for Chinese Medicine, identified prolonged fever and "hot blood" syndromes as the main illnesses for which they would prescribe rhino horn, but also included hepatitis, leukemia, hemorrhage, rhinitis, meningitis, cerebrovascular diseases, gastrorrhagia and severe external burns (Nowell *et al.,* 1992). Song and Milliken's (1990) review of 16

prescriptions from the Republic of Korea containing rhino horn indicated that they were used to treat fever, as well as many other conditions ranging from paralysis to bed-wetting and trouble with speech (Table 10). The 1962 Japanese Traditional Phamacological Encyclopedia listed rhino horn as antipyretic, sedative, detoxificant, and a cure for children's measles, while a later text (Akamatsu, 1980) prescribed rhino horn-containing medicines for a number of other ailments (Table 11).

Table 11: Japanese prescriptions for rhino horn and their applications (Akamatsu, 1980)

犀角解毒湯 (saikaku gedoku toh): measles

犀角湯 (saikaku toh): haematemesis

養心安神丸 (youjin ansin gan): sleeplessness

中行円 (chukoen/chugyoen): gout

犀角麻黄湯 (saikaku maou toh): beriberi

犀角丸 (saikaku gan): 癰疽 swelling/tumor

犀角丸 (saikaku gan): 瘰癧 tuberculous cervical lymphadenitis

犀角飲子 (saikaku inshi): 聤耳 otitis

琥珀犀角膏 (kohaku saikaku kou): stomatitis

In Viet Nam, rhino horn has commonly been used to treat high fevers and convulsions, to control hemorrhaging, and to assist the liver in cleansing the blood of toxins resulting from alcohol or poison. It is also reportedly used to treat people who suffer from epilepsy, high blood pressure, allergy, measles, stroke, long-term sleeping disorder or who have "fallen down from a height", presumably resulting from dizziness (Milliken *et al*., in prep). According to Do *et al.* (2006), when burned and mixed with agarwood, betel nut and radish seeds, rhino horn powder can also "cure cholera". Use as a non-specific health tonic was first mentioned in the Divine Peasant's Herbal and persisted until recently (Nowell *et al.,* 1992; Song and Milliken, 1990). For example, the primary manufactured medicine which included rhino horn as an ingredient sold in Japan in the early 1980s was 'Kyushin', which was widely sold as a daily "restorative" for those suffering irregular palpitation, shortness of breath and similar ailments (T. Milliken, *in litt*.)

3.2. Changing beliefs: from cancer cure to hangover cleanser

While some medicinal uses of rhino horn have changed little from ancient times, it also appears to be gaining new applications. Oddly, it appears increasingly to be reputed both a life-saving treatment for critical illnesses such as cancer and strokes, as well as more recreational uses such as an aphrodisiac or a detoxifying cleanser after imbibing too much alcohol. That these beliefs are spreading is indicated by the fact that this literature review found discussion of them mainly in news articles. That these beliefs are recent is indicated by the fact that this literature review found little study of these uses in either the traditional medicine or conservation literature. However, at least two such studies are in preparation (Milliken *et al.,* in prep; Saving Rhinos, 2012b), so that more information should soon be available.

As a medicine, rhino horn has been suggested for recent emerging serious diseases such as AIDS (Wu and Lu, 1986) and SARS (Han, 2009), indicating a belief that rhino horn can help the even dire cases. News articles have sometimes contributed in spreading this belief. One example is the sensation surrounding the

case of a Chinese celebrity who recovered using a prescription that originally contained rhino horn (multiple Chinese language news reports summarized by TRAFFIC, *in litt*.):

> *A well known television news anchor and reporter (Liu Hairuo) was declared brain-dead in England after a serious train accident in 2002. Brought back to China with a sustained high fever and resistance to all antibiotic drugs, she was reportedly treated with "AnGong NiuHuang" (a classical prescription which traditionally included rhino horn), which reportedly controlled the fever in seven days, after which she revived and regained consciousness. This resulted in a great public interest in the AnGong NiuHuang medicine. Still in production, since 1993 it has contained water buffalo horn instead of rhino horn, but on the Chinese market researchers have seen manufactured medicines which claim to contain rhino horn and claim to be produced before the 1993 trade ban, although it is believed that these are largely fraudulent. Such medicines have been found on Internet auction sites at very high prices (RMB400,000 per pill, or over USD63,000) with promotion of life-saving qualities.*

There have also been news reports of people in Viet Nam who have sought to cure leukemia and diabetes with rhino horn (Smith, 2012). In one, an emaciated man diagnosed with leukemia reported spending more than two months wages on a piece of rhino horn and used it to no effect, although he now wonders whether he had purchased a fake. Other reports concern a famous Vietnamese folk singer who allegedly depended on rhino horn to treat his diabetes, according to his former driver, who described how the doctor would prepare the rhino horn by first grinding it into powder, mix it with water and pour it into a bottle. Since the singer is now deceased, it will be difficult to further investigate this case (Smith, 2012).

There has been great concern that in Viet Nam rhino horn is now believed to be a cure for cancer. This was described by the CITES Secretariat at the 15th Conference of the Parties based on a mission of August 2009:

> *The Secretariat has heard, from a variety of sources, suggestions as to what may be prompting the dramatic increase in demand for rhinoceros horn that has taken place in recent years. Following its mission to Viet Nam, it is satisfied that, to a significant degree, it is being driven by a belief that rhinoceros horn may prevent persons from contracting cancer. It is apparently also believed that the ingestion of powdered rhinoceros horn will halt the progress of cancers among those already suffering from the disease. It seems this belief is spreading throughout parts of east Asia, but is especially strong in Viet Nam and China. Huge sums are being demanded of cancer sufferers from those who are trading in rhinoceros horn. A significant market also seems to have developed in the production and sale of fake rhinoceros horn. As might be imagined, some people who have contracted cancer (or their relatives) are willing to pay almost anything in the belief that they can enter a state of remission. Should these beliefs continue to spread, poaching of rhinoceroses in the wild is likely to continue unabated and perhaps increase even further* (CITES, 2010).

Hanoi traditional medicine dealers, since 2009, have told non-governmental organization researchers that they have heard about famous people with cancer being cured by rhino horn (Milliken *et al*, in prep.). News reporters for *Time* magazine also interviewed a woman with cancer who said she had purchased expensive rhino horn (USD2,000) on her doctor's recommendation (Beech and Perry, 2011). A popular Vietnamese language website had an article about the rhino horn "cancer-curing myth that is growing everywhere in Saigon" (Smith, 2012).

The origin of this belief is difficult to trace (Milliken *et al*., in prep); in classic Chinese medicine (the root of all the traditional Asian medicinal disclipines covered in this review) there was no concept of cancer, although tumors were known (Walters, 1993). Nowadays, of course, cancer is widely recognized by the TCM community (as evidenced by an Internet search on traditional medicine and cancer), and the recommended treatments appear to vary widely by practitioner. Recently several traditional medicine authorities have stated publicly that rhino horn is not an effective treatment for cancer. For example, the San Francisco based-President of Council of Colleges of Acupuncture and Oriental Medicine said, "the overwhelming demand [for rhino horn] derives from a non-traditional and unproven use – as a cure for cancer. There is *no evidence* that rhino horn is an effective cure for cancer and this is *not documented in TCM nor is it approved by the clinical research in traditional Chinese medicine"* (Huang, 2011). The President of the UK Association of Traditional Chinese Medicine, Huijin Shen, told a reporter for a special issue of *Nature* on traditional medicine that "in fact, in nearly two millennia, there is no record of rhino horn as a treatment for cancer" (Graham-Rowe, 2012). The Chair of the CITES Related Issues Liaison Committee of the Federation of Pharmaceutical Manufacturers' Associations of Japan (Y. Shimada) told TRAFFIC researchers assisting with this review that "use of rhino horn for cancer is not recognized" (TRAFFIC, *in litt*., 2012). A Vietnamese official visiting South Africa in 2011 on a mission to improve rhino horn trade controls between the two countries told a news reporter, "We need to raise public awareness of the importance of biodiversity, and we need to get rid of the wrong understanding that rhino horn can cure cancer" (Bryson, 2011).

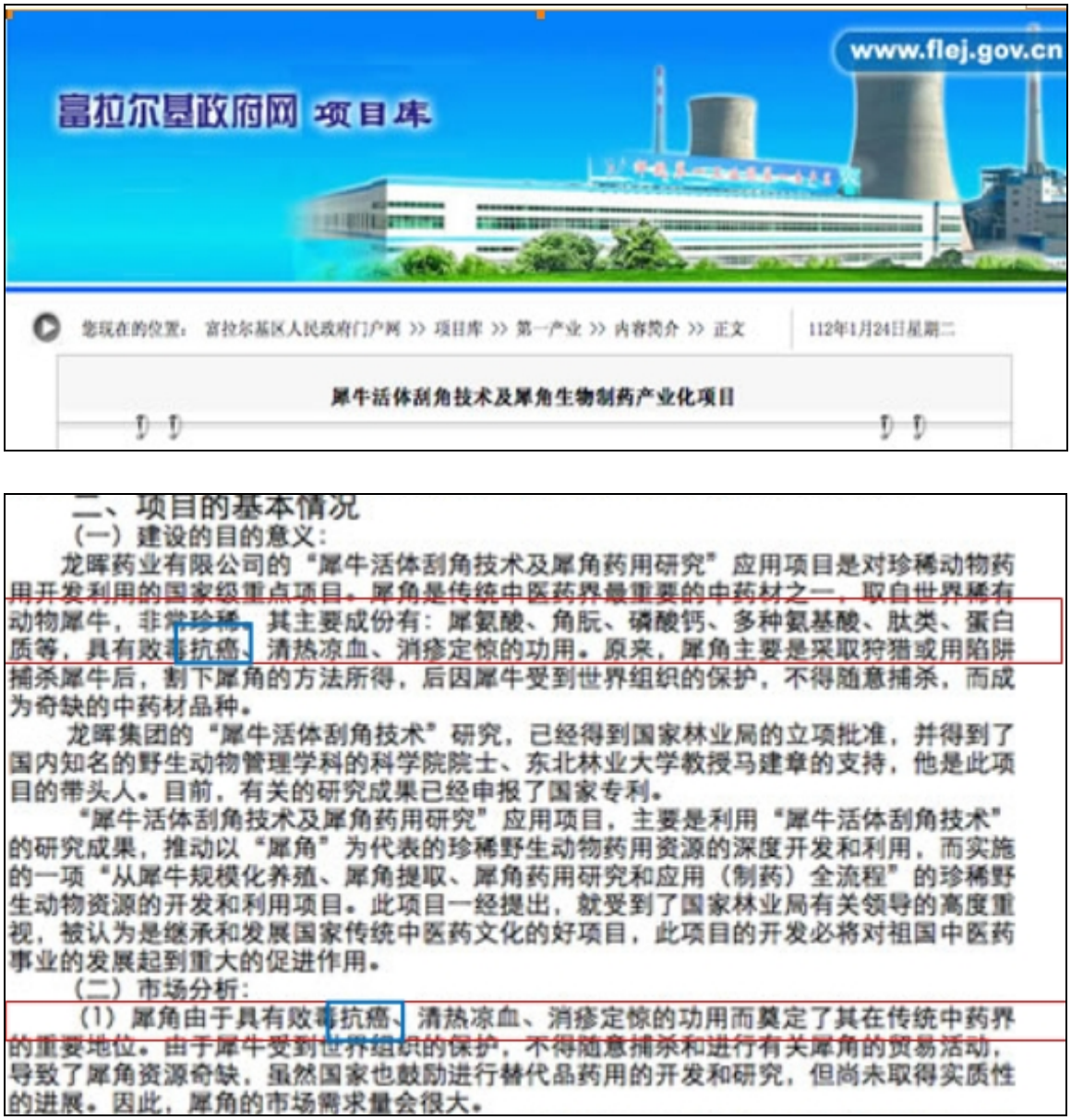
Most traditional medicinal texts examined by this literature review, including those followed in Viet Nam, do not include cancer among the diseases considered treatable with rhino horn, although a few suggest that rhino horn could be used to treat tumors (Akamatsu, 1980; Li, 1998; Table 9). However, these references are unlikely to be the source of the current and very recent belief that rhino horn can actually cure cancer. An example of a strong believer is the President of the Viet Nam Oriental Traditional Medicine Association. When South African officials visited in Hanoi in October 2010, he suggested that rhino horn could play a useful role in treating cancer, noting that its intrinsic detoxification properties would work to mitigate the abnormal cellular development that occurs in cancer patients. He further speculated that rhino horn usage could be increasing in Viet Nam because instances of cancer have increased appreciably in recent years (Milliken *et al*., in prep). Still, one Viet Nam medicinal dealer selling rhino horn told a writer for *Swara* magazine posing as a customer, "You are dreaming. Rhino horn can never cure cancer" (Amman, 2011).

While it is unknown how cancer got added to the list of diseases believed treatable with rhino horn, recently some businesses have been marketing rhino horn as a cure for cancer. One example is the Longhui Pharmaceutical Company in China, which has announced plans on its website in 2006 to farm rhinos imported from South Africa, shaving slices off the horns of live animals. Its website claims "anti-cancer" properties for rhino horn (Figure 7), stating "Rhino horn is very important in the Chinese medicine field because of its effects: detoxification and anti-cancer, eliminating pathogenic heat from the blood, removing eczema" (translation by Saving Rhinos, 2012a). Several other Chinese and Vietnamese websites of other companies and individuals advertising rhino horn as a cure for cancer have also been found (R. Cota-Larson, *in litt*. 2012; TRAFFIC, *in litt*. 2012; Milliken *et al*., in prep).

Use of rhino horn to treat strokes was another serious human ailment which the Standing Committee was concerned with, as discussed in the Introduction. Unlike cancer, there is more support for this in the traditional medicine literature, although not in Japan, according to the Pharmaceutical Manufacturers

Association (TRAFFIC, *in litt*. 2012). The Viet Nam Oriental Medicine Association told NGO investigators that one of the four common medicinal preparations including rhino horn, An Công Nguu Hoàng Hoàn, was indicated for treatment of stroke and blockage of blood in the brain (Milliken *et al*., in prep.), The most common medicine sold in the Republic of Korea prior to 1994 with rhino horn as an ingredient, Uhwongchungshimwon, was indicated for stroke (while also for hysteria, insomnia and bed-wetting, among others) (Table 10). Another classical Chinese formulation, Angong Niuhuang, is currently used in the treatment of severe brain trauma, as in the case of the Chinese celebrity described above and as

Figure 7: Excerpts from a Longhui Pharmaceutical Company webpage (on the Fularji District Government website) claiming in several places that rhino horn is "anti-cancer" (blue box highlight). (Saving Rhinos, 2012 and TRAFFIC, in litt.)



outlined by medicinal research by Lu *et al*., (2011). Yet when this formulation was first developed in the late 1700s, it was with a typical heat-clearing and detoxifying function, not suggestive of anything involving blood loss to the brain (TRAFFIC, *in litt., 2012*). One review of stroke therapy in traditional Chinese medicine identified over 100 formulas used for stroke (not including rhino horn), suggesting that traditional medicine

has many potential substitutes for rhino horn (Gong and Sucher, 1999). However, a review of 199 controlled trials found that any primary effect of 59 commonly used Chinese traditional medicines on stroke outcome could not be conclusively demonstrated (Wu *et al*., 2007).

A stroke results from an interruption of the blood supply to the brain, and can result either from an arterial blockage (ischemic stoke, the most common type) or from loss of blood (arterial rupture). Two scientific studies found that rhino horn can stem bleeding and speed coagulation (Park and Kim, 1991; Liu *et al*., 2011). However, one news story in Taiwan (Province of China) highlighted the dangers of people self-treating with rhino horn for a serious condition such as stroke. The report described how a recovering stroke patient who suddenly took a turn for the worse one day after taking rhino horn powder on the advice of a friend. A traditional doctor interviewed for the story said that rhino horn would constrict the blood supply and was contraindicated for ischemic stroke (Anon., 2006).

Other news stories have also highlighted the dangers of taking rhino horn as a medicine without consulting a doctor. In June 2011, a Viet Nam newspaper reported the following story (Education for Nature-Vietnam, 2011):

> *"A 21 year old woman, Hang, from Hoan Kiem, Hanoi revealed she had spent a large amount of money buying rhino horn to treat her mouth rash after trying other medicine without success. Hang tried rhino horn as a treatment after reading a document that indicated rhino horn was a good medicine for releasing heat and poison as well as for the treatment of mouth-rash. Two days after Hang used the rhino horn to treat her mouth rash she developed further erythema and pimples. The irritation also spread to her face and arms and she developed a fever. When Hang went to the Clinical Allergy - Immunity Department in Bach Mai Hospital, her disease was diagnosed as an allergic reaction due to poisoning as a result of using the rhino horn medicine. Dr.Nguyen Huu Truong from the Allergy Clinic, Immunity Center in Bach Mai Hospital said there is no evidence to prove that rhino horn reduces fever. In addition, rhino horn can cause an allergic reaction and poisoning due to unfamiliar ingredients in the mixture. People are warned not to self-medicate with rhino horn but instead to seek the advice of a doctor for the treatment of their illness.*

Viet Nam is also apparently the source for other new uses of rhino horn; not only is it being promoted as a "miracle" drug, but also in ways akin to a recreational drug. For decades conservationists have tried to dispel the myth rhino horn was used in Asia as an aphrodisiac, instead insisting that the problem was that it was considered an important medicine for human health. In discussing how rhino horn is used as a medicine, one Vietnamese traditional text added, "recently, it has been used as a powerful aphrodisiac" (Do *et al*., 2006). Rhino horn and other rhino parts are brewed with rice wine to make "tuu giac" ("rhino wine") to improve the sexual prowess of men, and there have been reports of rhino wine parties, according to non-governmental organization research (Milliken *et al*., in prep). One news report quoted from articles on popular Vietnamese language websites proclaiming that "*rhino horn with wine is the alcoholic drink of millionaires*" and that such a drink is "*like a luxury car*" (Smith, 2012). One Vietnamese-language webpage claimed that "*rhino horn is more effective than Viagra allowing men to have sex for two to four hours*" (Smith, 2012).

In Viet Nam rhino horn's alleged detoxifying properties have also been extended to hangovers. Milliken *et al*., (in prep). concluded, "in fact, the reported efficacy of the detoxification properties of rhino horn, especially following excessive intake of alcohol, is probably the most common routine usage promoted in the

marketplace" (A standard traditional medicinal textbook in Viet Nam highlights rhino horn's facilitation of the "liver, kidney and spleen detoxification process" (Do *et al*., 2006), and a recent news article interviewed a young woman whose wealthy father had purchased a chunk of purported rhino horn for her. She showed the reporter how she ground it into powder and said she took it with water several times a month for hangovers (Ives, 2012).

These new developments of rhino horn as an aphrodisiac or as a luxury wine parallels the evolution of tiger bone, another endangered species ingredient in traditional medicines. While tiger bone was traditionally prescribed for the treatment of arthritic conditions, tiger farmers in China are marketing tiger bone wine for banquets and as a sex tonic (Nowell and Xu, 2007).

3.3. The rhino horn medicine market: attitudes, availability and antiques

Individuals acquire rhino horn in a variety of forms through a variety of channels, which nowadays include direct purchase via Internet auction sites, a distribution channel that is growing exponentially (Wu, 2007). In China, Japan and the Republic of Korea, as in many overseas communities, the prevalent form of distribution in the past was by buying manufactured medicines including rhino horn as an ingredient, generally from a traditional pharmacy, either on a the advice of a doctor or on their own (Milliken *et al*., 1994). As the President of the UK Association of Traditional Chinese Medicine said, "For TCM you don't need a prescription – you can buy any Chinese medicine over the counter" (Graham-Rowe, 2012), and based on the experience of the researchers contributing to this literature review this is the case in all the selected study markets.

While the factory production of medicines containing rhino horn appears to have ceased in the study locations, as manufacturers have complied with domestic trade bans, the main medicinal distribution channel today is probably through traditional pharmacies that prepare prescriptions from dried ingredients. This distribution channel is difficult to monitor and detect illegal trade due to the large numbers of shops, clinics, hospitals, pharmacies, doctors and informal doctors. The forms of rhino horn which such retail outlets might carry also differ. In Viet Nam, rhino horn pieces, weighing 25-500 grams, have been found in pharmacies (Milliken *et al*., in prep.; Figure 8). In Taiwan (Province of China), surveys in 1991 of over 1,100 traditional pharmacies by college students found horn pieces were held by 24% of the more than 300 pharmacies with rhino horn; 30% having whole horns and 67% pre-ground powder (Nowell *et al.,* 1992). Pharmacies and doctors ground horn powder on the spot for issuing to patients. The pre-ground powder was widely reputed actually not to contain much or any rhino horn and sold at a lower price (Nowell *et al.,* 1992).; this trend of lower price for pre-ground "rhino horn"

Figure 8: An 87 gram slab of purported rhino horn in Viet Nam, where trade in horn pieces is most common (Amman, 2011)

powder was also seen in 2005-2006 during a TRAFFIC survey in China (TRAFFIC, *in litt*., 2006).

In Viet Nam, the practice of using rhino horn on its own for self-medication seems more prevalent than anywhere else in Asia (TRAFFIC, *in litt*., 2012), although it is also mixed with other ingredients. There, rhino horn is ground in a special porcelain 'rhino' bowl with a serrated bottom filled with water until it becomes a milky solution for drinking (Milliken *et al*., in prep). This practice stems from China, although there the rhino horn-water mixture is more usually added to a herbal decoction of other medicinal ingredients steeped in boiling water (But *et al.,* 1990).

Rhino horn has historically been a scarce commodity for traditional medicine in Asia, and thus was infrequently used when compared to other ingredients. For example, 43 retail pharmacists surveyed in Taiwan (Province of China) by TRAFFIC researchers in cooperation with the Society for Chinese medicine in 1991 estimated an annual average sales volume of 48 grams, at a time when Taiwan (Province of China) was considered to be the largest consumer market for rhino horn (Nowell *et al.,* 1992). In 1998 surveys only 1% of 1,172 people surveyed in Japan said they had ever taken rhino horn medicines (JWRC, 1998). Today it is clear that the vast majority of traditional medicinal practitioners are complying with domestic and international rhino horn trade controls, and using substitutes to treat conditions for which rhino horn would traditionally be indicated.

However, a belief that it is an important medicine persists. For example, only one-third of 256 members of the Association of Korean Oriental Medicine and the Korean Oriental Drug Association who responded to a mail survey carried out by the associations in cooperation with TRAFFIC and the Ministry of Health and Welfare said that the ban on rhino horn did not have a negative effect on their ability to treat patients (Kang and Phipps, 2003). A senior official at the China National Group Corp. of Traditional and Herbal Medicine suggested that the Chinese government stockpile rhino horn as an emergency treatment for disease outbreaks (Han, 2009).

The belief in rhino horn as an important medicine stems as much from direct experience as from traditional medicinal texts. In 1991, one traditional doctor in Taiwan (Province of China) wrote an article arguing that rhino horn was an "irreplaceable" medicine:

> "*During the 1960s, my clinic saw many young patients. During that period encephalitis and poliomyelitis were widespread; many patients went to big Western hospitals and underwent treatment to reduce high fever, only afterwards to fall victim to polio or dull-wittedness. This is because the growth of disease-causing microorganisms is closely correlated with temperature: if the temperature is too high, the environment is not suitable for microorganismal growth. An infection by a viral or bacterial agent will cause the temperature to rise in the human body due to the immune system. When the body's temperature was forced down by the Western medicine used at that time, the lowered temperature creates a suitable environment for the growth of dangerous disease-causing microorganisms – which may sometimes attack the nervous system and cause polio. I have cared for many patients who went to big hospitals where doctors were unable to bring down their fever, whether such patients have high fever in combination with either convulsions or coma or just fever alone, rhino and Saiga antelope horn can cure their symptoms almost every time. Successful cases include my own son, who once ran a continued high fever for 30 days.*" (Chen, 1991 translation in Nowell *et al.,* 1992).

Still, this is a minority view as, for example, 85% of doctors surveyed in the Republic of Korea did not consider rhino horn "indispensable" (Kang and Phipps, 2003), and many doctors and

Table 12: Distinct traditional attributes of rhino horn identified by TCM doctors, Bell and Simmonds (2007)

Table 3.1. Properties / functions of rhino horn used as criteria for herb selection

Criteria	Properties and functions of rhino horn
A	'Cold' nature
B	'Bitter' taste
C	'Salty' taste
D	'Blood cooling'
E	'Heat clearing'
F	Anti-convulsant
G	Anti-inflammatory properties
H	Anti-pyretic properties
I	Reduce haemorrhage

Table 13. Potential substitute herbs from traditional Chinese medicinal literature with similar properties, Bell and Simmonds (2007)

Table 3.2. TCM herbs selected after consultation with TCM practitioners and from evaluation of TCM literature and pharmacological and clinical data

Herbs with some similar properties to rhino horn	A	B	C	D	E	F	G	H	I	TCM references
1. *Scrophularia ningpoensis* Hemsl. (Scrophulariaceae) root = Xuan Shen	*	*	*	*	*		*	*		1, 2
2. *Rehmannia glutinosa* Steud (Scrophulariaceae) root = Sheng Di Huang	*	*		*	*		*			1, 2
3. *Paeonia suffruticosa* Andr. (Paeoniaceae) root = Mu Dan Pi	*	*		*	*	*	*			1, 2
4. *Paeonia veitchii* Lynch or *P. lactiflora* Pall. (Paeoniaceae) root = Chi Shao	*	*		*	*	*	*		*	2
5. *Arnebia euchroma* I.M.Johnst. (Boraginaceae) root = Zi Cao	*		*	*	*		*			1
6. *Isatis indigotica* (Brassicaceae) root = Ban Lan Gen	*	*		*	*		*	*		1, 2
7. *Lonicera japonica* Thunb. (Caprifoliaceae) flower bud = Jin Yin Hua		*		*	*	*	*			1, 2
8. *Forsythia suspensa* Vahl (Oleaceae) fruit = Lian Qiao	*	*			*		*	*		1, 2
9. *Salvia miltiorrhiza* Bge (Lamiaceae) root = Dan Shen *	*			*		*			1,	2

Criteria A – I (refer to Table 3.1.): based on TCM literature (Bensky and Gamble, 1993[1]; Chinese Pharmacopoeia, 2005[2]).

See Table 12 above for description of criteria A – I in Table 13.

researchers have put forward viable and affordable substitutes. Other animal horns are commonly suggested as substitutes, particularly water buffalo horn, which is the official replacement for rhino horn in the Chinese national pharmacopoeia. Many herbs have also been suggested, for example, a project supported by the UK Department of Environment, Food and Rural Affairs carried out in cooperation with leading TCM practitioners in the U.K., identified herbal substitutes based on pharmacological properties of rhino horn (Table 12 and 13). Subsequent laboratory testing of the herbs demonstrated anti-bacterial and anti-inflammatory effect, in contrast to rhino horn, which was also tested and had no such effects (Bell and Simmonds, 2007).

When the consumer knows he or she is using an ingredient other than rhino horn, such as water buffalo horn, that is substitution, which has been encouraged by government authorities (particularly in China) and conservationists, who have worked with traditional medicine authorities to identify substitutes (e.g., Nowell *et al.*, 1992; Kang and Phipps, 2003). However, availability of fake horn is widespread, with both consumers and doctors/pharmacists being cheated when they think they have acquired the *bona fide* article. Ground powder that is reputed to be rhino horn but is actually water buffalo horn is not substitution but a fraudulent practice that perpetuates illegal use of rhino horn in medicine even if it doesn't contain any. This is not an uncommon practice in Chinese medicine, whole pictorial encyclopedias, with diagnostic keys, have been published to help distinguish real medicinal ingredients, both plant and animal, from fakes (Lin and Chen, 1988; see also Ye and Yuan, 1989; Li, 1990). A Vietnamese traditional medicine text said, "Being rare and expensive, rhinoceros horns are often tampered with water buffalo horns (thuy nguu giac) and chamois horns" (Do *et al.*, 2006). A writer for *Swara* magazine contracted DNA testing of pieces of horn sold to him as rhino by two traditional pharmacies in Ha Noi and found both were fake. After confronting the men about the fakes, they were taken to a factory and filmed production of the imitation horn. The writer suggests, based on

his observations, that 90% of the rhino horn offered to consumers in Viet Nam was fake. However, one piece of horn he purchased was real, from a white rhino (*Ceratothium simum*) (Amman, 2011).

Most research on attitudes has focused on practitioners, as described above, as they are the dispensers of rhino horn in medicines, and there has been comparatively little study of consumers' attitudes. In Japan, only 17% of 1,172 people surveyed were familiar with rhino horn as a medicine (and just 1% said they had ever taken any) (JWRC, 1998). Currently, conservationists are focusing on consumers in Viet Nam, with a study and a public awareness campaign underway by Environment Vietnam (Saving Rhinos, 2012b). Thus far, TRAFFIC research in Viet Nam has identified four consumer groups (Table 14), only one of which includes people who are seeking treatment for a current illness. Most disturbing to the researchers is the rising use of rhino horn (and other endangered wildlife products) as a status symbol, with modes of consumption quite divorced from the traditional medicinal perception of rhino horn as a treatment for sickness.

Availability of rhino horn to potential consumers has generally been researched using covert market surveys, where the researcher poses as a customer seeking rhino horn (Song and Milliken, 1990; Nowell *et al*., 1992; Mills, 1993; Mills, 1997). Rhino horn, being illegal, is rarely openly displayed, so that inquiries must be made. The most recent survey was carried out by TRAFFIC in China in 2005-2006 (TRAFFIC, *in litt*., 2006). The primary investigator carried a prescription written with the cooperation of a prestigious doctor on his letterhead, a traditional formula which included rhino horn

Table 14: Rhino horn consumer groups in Viet Nam (Milliken et al., in prep)

Group	Use of rhino horn
Wealthy, generally middle-aged, high status individuals, including Vietnamese as well as overseas Chinese, Korean and Japanese	Detoxifying rhino wine, consumed at special social occasions as well as on a more regular basis as a rejuvenating tonic. Within this group, social status is attached to one's ability to consume rhino horn more casually without being overtly ill.
People seeking friendship and favors with expensive gifts	Whole rhino horns are known to have been given as gifts to high-ranking political figures who were subsequently caught by authorities
People with serious illness	Ground to powder with water in traditional medicinal form
Mothers stocking rhino horn pieces for home use, especially medicine for young children	TRAFFIC has monitored an Internet chat forum in which young mothers, who strongly believe that rhino horn can lower fever, are seeking bona fide pieces of rhino horn to keep at home in case other medicines are not able to cure their children's fever.

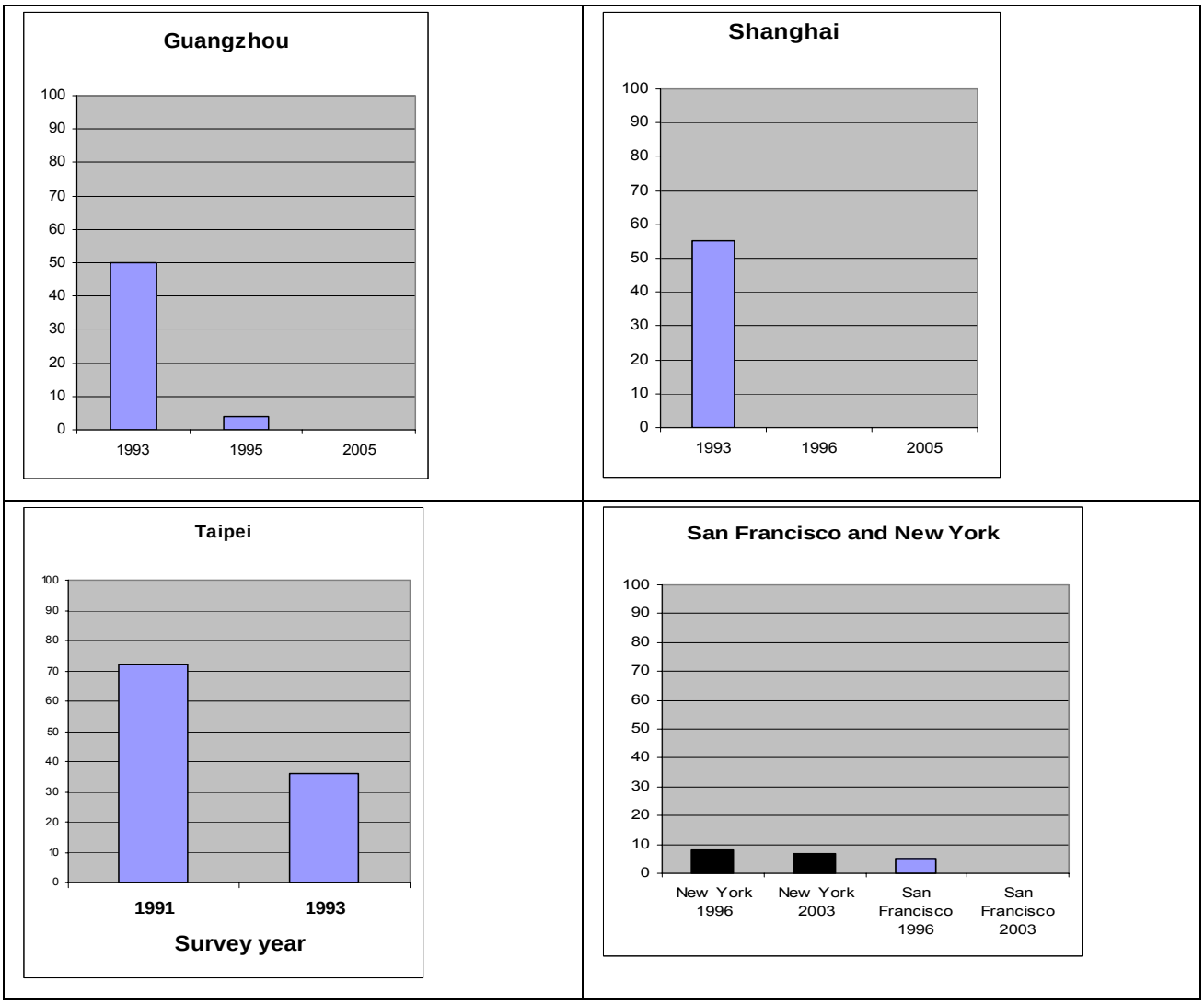
among other protected species' ingredients. Most pharmacies said that they did not carry rhino horn, 98% of 449 retail pharmacies surveyed (Table 15). Availability of rhino horn was higher in wholesale markets, which suggests there might be more consumers at this level than at the retail level where people seeking treatment are likely to go. Wholesale vendors were also less likely to volunteer knowledge of its illegality.

Table 15: Results of 2005-2006 surveys of retail and wholesale traditional medicine shops across China (TRAFFIC, in litt., 2006)

Retail shops willing to sell rhino horn (489 surveyed)	Percentage saying that it was illegal	Wholesale shops with rhino horn (140 surveyed)	Percentage saying that it was illegal
2.2% (11)	61% (298)	6% (9)	27% (19)

In general, however, surveys conducted in major retail markets before and after law enforcement actions and public education have shown greatly reduced availability over time (Figure 9 shows time lapse surveys in five different large cities). An example of the impact of law enforcement on the market is Taiwan (Province of China), which was once a major consuming market for rhino horn, with 77% of 1,162 pharmacies around the island stocking it (Nowell *et al.*, 1992). After publicizing the prohibition of rhino horn in medicines, government authorities visited 519 traditional pharmacies in March 1994 and found rhino horn in only 6.5% pharmacies visited. The next month, officials at the county

Figure 9. TRAFFIC time-lapse market surveys find reduced availability of rhino horn in retail pharmacies after trade prohibitions and public awareness

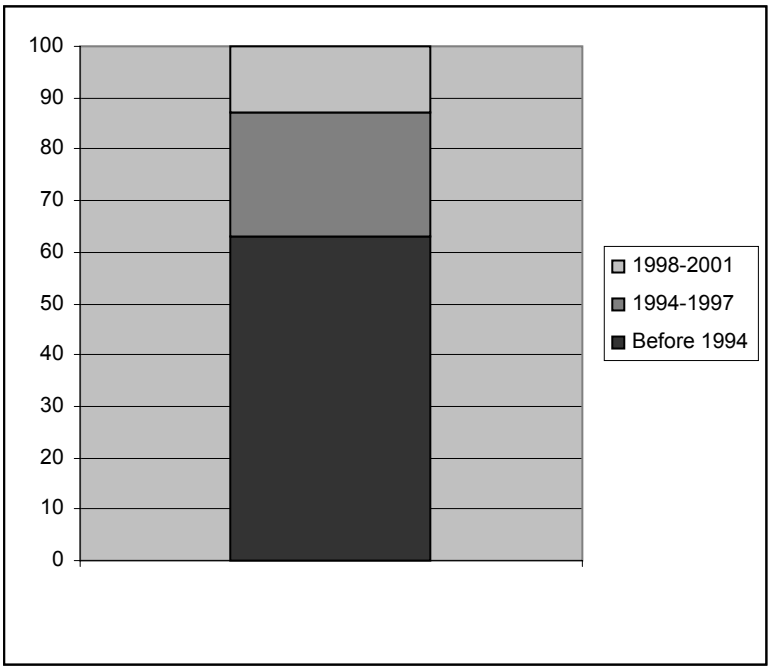


Columns show percentage of retail pharmacies surveyed willing to sell rhino horn; rhino horn possession by the shop was not verified in all cases. Sources: Taipei 1991: Nowell *et al.* (1992); Taipei 1993: Loh and Loh (1994a); Guangzhou and Shanghai 1994: Loh and Loh (1994b); Guangzhou 1995 and Shanghai 1996: Mills (1997); Guangzhou and Shanghai 2005: TRAFFIC, *in litt*.; New York and San Francisco: Henry (2004)

level also participated and 5,623 shops were visited, and only 0.22% were found selling rhino horn (Nowell, 1998). An example of the impact of public education is seen in Figure 9. San Francisco surveys showed better results than New York, an effect attributed to extensive outreach there to the traditional medicine community (Henry, 2004).

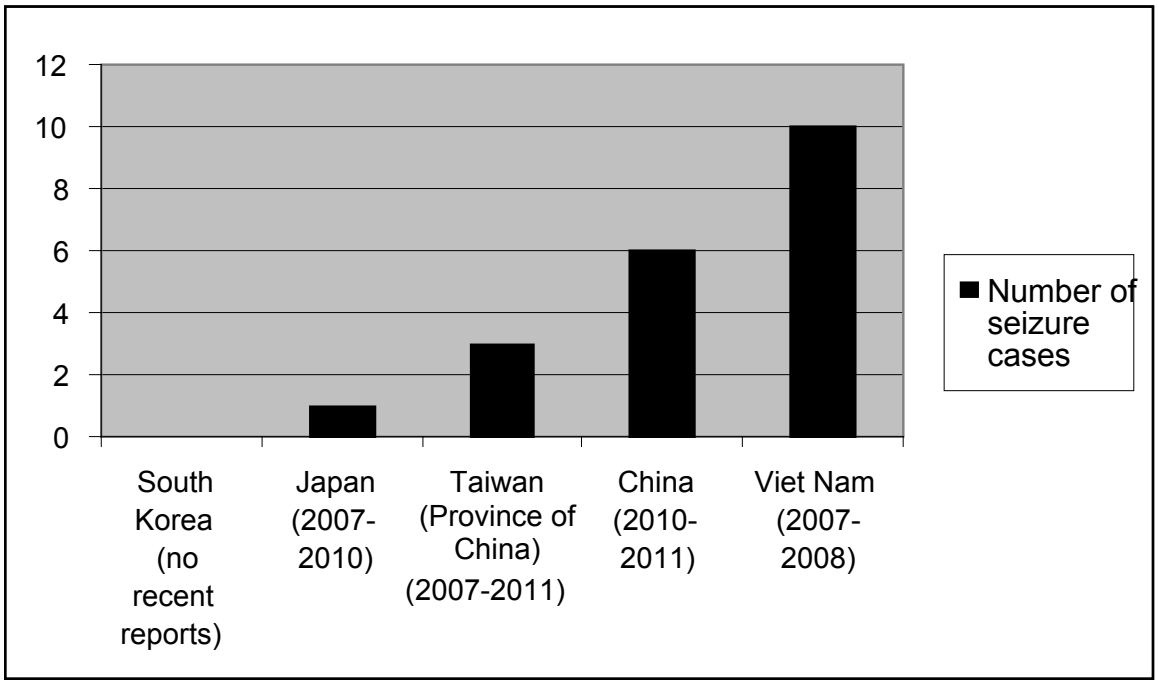
Although there have been no recent surveys of the retail market of rhino horn in the Republic of Korea, an attitudinal survey of traditional doctors and pharmacists indicated declining usage (Kang and Phipps, 2003) from levels recorded in 1993 when 54% of shops surveyed by TRAFFIC had rhino horn (Mills, 1993). The attitudinal survey was carried out in cooperation with traditional medicine societies and the Ministry of Health and Welfare, and most of the 130 practitioners (half the survey sample) who responded to a question asking when they last dispensed rhino horn indicated that they not done so since its prohibition (Figure 10).

Figure 10: Percentage of practitioners in the Republic of Korea who have not used rhino horn since trade was prohibited in 1994 (after Kang and Phipps 2003)



Although no market surveys of the type described above have yet been carried out in Viet Nam, anecdotal observations of the medicinal market (Amman 2011, Milliken *et al.*, in prep) indicate that rhino horn is more commonly for sale in traditional medicinal markets here than in the other four locations examined. The significance of Viet Nam as a destination for rhino horn is also indicated by a preliminary review of seizures: government authorities there intercepted at least ten cases involving illegal movements of rhino horn (mainly pieces of horn but some whole horns as well) over the two year

Figure 11. A preliminary review of government seizures of rhino horn in the five selected study locations



Sources: Viet Nam (Milliken *et al*., in prep.); all others TRAFFIC, *in litt*., 2012

period of 2007-2008 (Milliken *et al,* in prep.), more so than in China, a much bigger country (Figure 11).

Viet Nam's contemporary usage and trade in rhino horn is essentially a recent phenomenon, despite the long medicinal tradition, as described by Milliken *et al*., (in prep.):

> *In the 20th century, rhino horns were not commonly marketed to the general public until the end of the 1990s when the country began experiencing consistently high economic growth rates. In March 1990, an early study of Viet Nam's wildlife trade reported a host of products openly sold in Hanoi's medicine markets, including tiger bone, pangolin scales, primate skeletons and dried gekko, but noted the absence of rhino horn* (Martin, 1992)*. Since then, the combination of a larger consumer market with greater levels of disposable income and the presence of Vietnamese middleman traders in key source countries in Africa, especially South Africa, has apparently underpinned a rapidly escalating use of and trade in rhino horns. Only over the last decade have rhino horns been imported directly to Viet Nam from Africa, and the demand for rhino horn medicines begun to increase.*

The market for rhino horn has inflated to the degree that there is a resurgence of interest in antique and modern rhino horn art objects such as carvings. In the past, Martin (1990) saw antiques being pulverized for medicines in China. However, today it is unlikely that high-priced antique carvings are being used for medicine and historically the medicinal industry has supplied the market rather than bought from it. In Taiwan (Province of China) before such sale was prohibited, the main medicinal wholesale district in Taipei sold horns not only as medicine but also onto the art market, for carving into statues or incense bowls. Antique carvings were also being smuggled in from China (Nowell *et al.,* 1992). In China in 2005, one medicine dealer with rhino horns for sale said that he had just sold a pair of rhino horn art carvings to a wealthy Beijing collector for RMB1 million (over USD158,000: TRAFFIC, *in litt*., 2006). TRAFFIC found around 190 unique

advertisements for rhino horn carvings over an eight-month weekly Chinese-language internet survey in 2005-2006 (Wu, 2007). Recent news articles attest to a burst of museum robberies to obtain rhino horns (from natural history museums) and especially rhino horn antiques. One article in *Der Spiegel* reported that "Officials at Europol, the European Union's criminal intelligence agency, claim the number of thefts of rhinoceros horns has increased sharply in Europe during the past year. Since 2011, the agency has recorded 56 successful and 10 attempted thefts. Criminals purloined horns from museums and private collections in 15 countries, with many of the thefts believed to be linked to "an Irish and ethnically Irish organized criminal group, who are known to use intimidation and violence to achieve their ends." The group is believed to be active in Asia, North and South America and Europe." (Ferguson, 2012). The end destination and potential medicinal use of the rhino horn items stolen in Europe is not yet clear.

4. Discussion

There has not been a great deal of scientific research on rhino horn, and most of it has been done in China, where rhino horn is only permitted to be used for research on viable substitutes for it. Six out of seven studies on non-human models found significant anti-pyretic effect, and two out of three found significant anti-inflammatory effect. There were stark geographic differences in the pattern of results, with positive results for rhino horn in all tests conducted in China examined by this review, and the two studies done in the UK and South Africa finding no effects at all. While the sample size is limited for comparison, and the differences could perhaps be due to methodological approaches, publication bias for positive results has been demonstrated in clinical trials of medical (both traditional and non-tradition) interventions in China (and other Asian countries) by a widely-cited review of Medline-indexed studies (Vickers *et al*., 1998). It is unclear whether negative results for rhino horn might be under-represented in the published scientific literature, but since positive pharmacological test results for rhino horn have not been fully replicated, they should not be regarded with a full measure of confidence.

Rhino horn has a very long history of use as an ingredient in traditional medicine, and to have been so long and widely embraced suggests that many people have experienced it as efficacious. However, rhino horn has been prohibited as a medicinal ingredient for nearly twenty years or more in the five selected study locations. While some in the traditional medicine community have advocated for rhino horn to be legalized (e.g. Du and Jia, 2008), the field has unquestionably made great advances without it.

A recent review of numerous Chinese and English traditional medical publications found that most authors support application of the standards of scientific evidence-based medicine and the use of randomized controlled trials in clinical tests to determine efficacy of traditional Chinese medicine treatments (Shea, 2006). These standards have not been applied to rhino horn; without such scientific validation, any future legal use of rhino horn as a medicine to treat illness, and especially life-threatening ones, should be contemplated with caution.

Rhino horn has always been a relatively scarce commodity, and is becoming more so. Rarity underpins the value rhino horn is acquiring as a luxury item (art carvings, "rhino horn wine for millionaires" in Viet Nam), and probably also contributes to the elevated and unwarranted reputation of rhino horn as a miracle medicine that can work when others fail. Rarity contributes to the very high reported prices for rhino horn, to the extent that people are taking great risks to poach rhinos and steal horns and horn carvings from museums. Rarity would seem to be the main factor, more than any intrinsic value or properties of the horn itself, coupled with rising wealth in East and Southeast Asia, which is inflating a bubble of demand for rhino

horn. In formulating recommendations to enhance existing rhino horn trade controls, Parties may want to review the legislative and policy, law enforcement, and demand deterrents that have been put forward to address illegal tiger bone trade, which like rhino horn is also prized in Asia for its historical medicinal reputation and current and illicit rarity.

Acknowledgements

This document was prepared by TRAFFIC on behalf of the CITES Secretariat, through contract CITES Project no. S-389, and does not necessarily represent the views of the Secretariat or the Parties. Contributions from Joyce Wu (TRAFFIC), Tom Milliken (TRAFFIC), Rhishja Cota-Larson (Saving Rhinos) and Laurie Fitzgerald Westover (University of New Hampshire, Department of Molecular, Cellular and Biomedical Sciences) are especially recognized. The contribution of the CITES Secretariat in reviewing a draft version of this report is also acknowledged.

References

Akamatsu, K. (1980) *New edition Wakan yaku* (新訂和漢薬). 3rd printing: First printing in 1970. Ishihaku Shuppan, Tokyo.

Amin, R., Bramer, M. and Emslie, R.H. (2003). Intelligent data analysis for conservation: experiments with rhino horn fingerprint identification. *Knowledge-Based Systems* 16 (5): 329-336.

Amman, K. (2011). The Vietnamese and rhino horn - a dealer speaks. *Swara* Oct-Dec 2011: 33-37

Anon. (1983). Pharmacological tests on rhino horn. *Swara* 6(1): 23.

Anon. (2006). Stroke patient: condition exacerbated after eating rhino horn. FTV 27 March. (http://news.ftv.com.tw/NewsContent.aspx?sno=2006327C02T1 &ntype=class)

Beech, H. and Perry, A. (2011). Killing Fields: Africa's Rhinos Under Threat. *TIME*, 13 June 2011, pp. 32-39.

Bell, C.M. and Simmonds, M.S.J. (2007). *Plant substances as alternatives for animal products in traditional medicines.* Report to the UK Department of Environment and Rural Affairs.

Bukey, F.S. and Rhodes, P. (1935). A comparative study of enteric coatings. *Journal of the American Pharmaceutical Association* 26(7): 567-570.

Bryson, D. (2011). South Africans, Vietnamese meet on rhino poaching. Associated Press, Sept 28.

But, P.P.H., Lung, Y.C. and Tam, Y.K. (1990). Ethnopharmacology of rhinoceros horn, I Antipyretic effects of rhinoceros horn and other animal horns. *Journal of Ethnopharmacology* 30: 157-168.

But, P.P.H., Lung, Y.C. and Tam, Y.K. (1991). Ethnopharmacology of rhinoceros horn, II Antipyretic effects of prescriptions containing rhinoceros horn or water buffalo horn. *Journal of Ethnopharmacology* 33: 45-50.

Butler, D.J., De Forest, D.R. and Kobilinsky, L. (1990). The use of isoelectric focussing to identify rhino keratins. *Journal of Forensic Science* 35 (1): 336-344.

CITES (2010). Species trade and conservation – Rhinoceroses: Report of the Secretariat. Doc. CoP15 45.1, CITES Secretariat, Geneva, Switzerland. 5 pp.

Du, Y.Y. and Jia, Q. (2008). Proposal on protecting and sustainable use of rhinoceros. *Rersource Development and Market* 24(9): 825-826.

Do, H.B., Dang, Q.C., Bui, X.C. *et al*. (2006). *Medicinal plants and animals in Vietnam, Volume II.* Publishing House for Science and Technology, Ha Noi.

Education for Nature-Vietnam (2011). *Woman poisoned by rhino horn*. Education for Nature-Vietnam, English translation viewed on 28 December 2011. http://www.envietnam.org/library/Articles%20for%20news%20media%20section/Woman_poisoned_by_rhino_horn.html

Feng, J.L., Song, X. and Luo, L.Y. (2006). Observation and nursing of blood aspect pattern caused by poisonous snake bit and treated using Rhinoceros Horn and Rehmannia Decoction. *Today Nurse* Aug: 99-101.

Ferguson, K.K.F. (2012). Trophy Hunting in Museums: Rhino Horn Thefts a Growing Problem in Europe. *Der Speigel* 13 March.

Gaski, A.L. and Johnson, K.A. (1994). *Prescription for extinction: Endangered species and patented Oriental medicines in trade*. TRAFFIC, Washington DC.

Ge, Z.C., Zhou, X.J. and Wu, L. (1997). Evaluation on similarity among inorganic elements components of buffalo horn, cattle horn to Guangjiao [African rhino horn] by multiple-goal decision making and idealized pattern. Department of Hygienic Chemistry, Jiangxi Medical College, Nanchang.

Gong, X. and Sucher, NJ. (1999). Stroke therapy in traditional Chinese medicine (TCM): prospects for druge discovery and development. *Trends in Pharmacological Sciences* 20(5): 191-196.

Govt. of China. (2006). *Report by the CITES Management Authority on Implementing Resolution Conf. 12.5 of CITES*. COP15 Doc. 52 Annex 1.

Graham-Rowe, D. (2012). Endangered and in demand. *Nature Medicine* 480: S101-103.

Gupta, R. and Ramnani,P. (2006). Microbial keratinases and their prospective applications: an overview. *Appl Microbiol Biotechnol*. 70(1):21-33.

Han, P. (2009). *Effectively utilizing traditional Chinese medicine in unexpected event.* Beijing, Strategic and Development Department, China National Group Corp. of Traditional & Herbal Medicine: pp. 1-10.

Henry, L. (2004). *A tale of two cities: a comparative study of traditional Chinese medicine markets in San Francisco and New York city*. TRAFFIC, Washington DC.

Hieronymus, T.L., Witmer, T. and Ridgely, R.C. (2006). Structure of white rhinoceros *(Ceratotherium simum*) horn investigated by X-ray computed tomography and histology with implications for growth and external form. *Journal of Morphology*: 267: 1172-1176.

Hsu, E. (2006). The history of qing hao in the Chinese materia medica. *Trans R Soc Trop Med Hyg*. 100(6):505-8.

Huang ,H.Q., Hsu, L.L. and He, J.L. (1959). Antipyretic effects of Asian and African rhino horns. *Wuhan Medicine and Hygiene* 2: 340-343. In But *et al.* (1990).

Huang, L., Liu, J.F., Liu, L.X. *et al.* (1993). Antipyretic and anti-inflammatory effects of Artemisia annua L. *Chinese Journal of Materia Medica* 18(1):44-8, 63-4.

Huang, L.X. (2011). Statement opposing the use of rhino horn in medicines by the American College of Traditional Chinese Medicine and Council of Colleges of Acupuncture and Oriental Medicine.

Huang, T.L. and Yu, P. (1997). Analysis of alpha-keratins in the horns of Rhinoceros and Buffalo using non-native capillary isoelectric focusing. *Chromatographia* 46(7/8): 437-439.

Ives, M. (2012). Vietnames rhino horn obsession threatens world populations; prices reach $55K per kilogram. Associated Press, April 4.

JWRC (Japan Wildlife Research Center) (1998) *Research on use for Kampo medicine of Endangered Species* (平成 9 年度絶滅のおそれのある種の漢方薬利用の現状等に関する調査). Prepared for Environment Agency, Japan.

Kang, S. and Phipps, M. (2003). *A question of attitude: South Korea's traditional medicine practitioners and wildlife conservation*. Hong Kong, TRAFFIC.

Karantza, V. (2011). Keratins in health and cancer: more than mere epithelial cell markers. *Oncogene* 30: 127-138.

Laburn, H.P. and Mitchell, D. (1997). Extracts of rhinoceros horn are not antipyretic in rabbits. *Journal of Basic and Clinical Physiology* 8 (1/2): 1-11.

Leader, B., Baca, Q.J. and Golan, D.E. (2008). Protein therapeutics: a summary and pharmacological classification. *Nature Reviews Drug Discovery* 7: 21-39.

Lee, T.H. (1995). Measures and current usage status in Korea of the medicine made with endangered species. In *Proceedings of the Seminar on International Trade in Endangered Wild Fauna and Flora*. TRAFFIC, Ministry of Environment, and Ministry of Health and Welfare, Seoul. In Kang and Phipps (2003).

Lee, S.K. and Kim, Y.E. (1974). Studies on the composition of hard tissue proteins extracted from rhinoceros horn, water buffalo horn and cattle horn. *Korean Biochemistry Journal* 7(2): 125-142.

Lee-Thorp, J., Armstrong, R. and Merwe, N. van der (1994). Isotopes and rhino horn. *REF Journal* 9: 14-18.

Li, S.Q., Zu, E.D. and Liu, L.J. (2011). Identification of rhinoceros horn and its substitutes. *Advanced Materials Research* 177: 636-639.

Li, Z.Q. (1998). Traditional Chinese medicine for primary liver cancer. World *Journal of Gastroenterology* 4(4): 360-364.

Li, Z.Y. (1990). How to distinguish fake rhino horn. *Northwest Pharmaceutical Journal* 1990: 17-20.

Lin, H. and Chen, S. (1988). *Original colour atlas for discriminating Chinese traditional drugs.* Science and Technology Press, Guangdong.

Liu, R., Duan, A.J. Wang, M. *et al.* (2011). Analysis of active components of rhinoceros, water buffalo and yak horns using two-dimensional electrophoresis and ethnopharmacological evaluation. *Journal of Separation Science* 34(3): 354-362.

Loh, J. and Loh, K. (1994a). Rhino horn in Taipei, Taiwan. *TRAFFIC Bulletin* 14 (2): 55-58.

Loh, J. and Loh, K. (1994b). A spot check on the availaibility of rhino products in Guangzhou and Shanghai, China. *TRAFFIC Bulletin* 14 (2): 79-80.

Lu, Y.F., Yan, J.W., Wu, Q. *et al*. (2011). Realgar- and cinnabar-containing an-gong-niu-huang wan (AGNH) is much less acutely toxic than sodium arsenite and mercuric chloride. *Chem Biol Interact*. 189(1-2):134-40.

Luo, J, Yan, D., Zhang, D. *et al.* (2011). Substitutes for endangered medicinal animal horns and shells exposed by antithrombotic and anticoagulation effects. *Journal of Ethnopharmacology* 136(1): 210-6.

Lynch, KA., Feola, P.G. and Guenther, E. 2003. Gastric trichobezoar: an important cause of abdominal pain presenting to the pediatric emergency department. *Pediatric Emergency Care* 19(5): 343-347.

Mainka, S. (1997). *Rhino progress? The response to CITES Resolution Conf. 9.14.* TRAFFIC International, Cambridge.

Martin, E.B. (1990). Medicines from Chinese treasures. *Pachyderm* 13: 12-13.

Martin, E.B. (1992). Observations on Wildlife Trade in Viet Nam. *TRAFFIC Bulletin Vol. 13 (2): 61-67.*

Milliken, T., Nowell, K. and Thomsen, J. (1994). *The decline of the black rhino in Zimbabwe: implications for future rhino conservation* TRAFFIC International, Cambridge.

Milliken, T. Shaw, J., Taylor, R.D. and Turton, C. (In prep.). *The South Africa - Viet Nam Rhino Horn Trade Dynamic: A deadly combination of government lapses, private sector greed and Asian crime syndicates.*

Mills, J.A. (1993). *Market under cover: the rhinoceros horn trade in South Korea*. TRAFFIC, Cambridge.

Mills, J.A .(ed). (1997). *Rhinoceros horn and tiger bone in China: an investigation of trade since the 1993 ban*. TRAFFIC, Hong Kong.

Modell, W. (1969). Horns and antlers. *Scientific American* 220: 114-122.

Nowell, K. (1998). *Consuming market indicators for rhino horn.* Unpublished report, TRAFFIC East Asia, Taipei.

Nowell, K., Chyi, W.L. and Pei, C.J. (1992). *The horns of a dilemma: market for rhino horn in Taiwan.* TRAFFIC, Cambridge.

Nowell, K. and Xu, L.(2007). *Taming the Tiger Trade: China's Markets for Wild and Captive Tiger Products Since its 1993 Domestic Trade Ban*. TRAFFIC, Hong Kong.

Ogata, J., Maeda, T. and Ida, T. (1960). Studies on the water-extract of saikku (horn of Rhinoceros spp.). *Bulletin of Yamaguchi Medical School* 9: 1940-1943.

Park, S.C. and Kim. S.H. (1991). The Effects of Seogagjihwantang and Kami-Seogaghihwangtang on Intravascular Coagulation Induced by Endotoxin in Rats. *Journal of Oriental Medical Pathology* Vol.6 (97-110).

Patton, F. (2011). *The medicinal value of rhino horn – a quest for the truth*. Unpublished report (first available on Rhino Resource Center: 1-8.

Rachlow, J.L. and Berger, J. (1987). Conservation implications of patterns of horn regeneration in dehorned white rhinos. *Conservation Biology* 11: 84-91.

Saving Rhinos. (2012a). Revealed: China's 'Rhino Horn Cancer Treatment' Scheme. Rhinoconservation.org, 26 January.

Saving Rhinos. (2012b). Leading the way: Vietnamese NGO launches rhino horn trade awareness campaign. Rhinoconservation.org, 14 March.

Shea, J. (2006). Applying evidence-based medicine to Chinese traditional medicine: debate and strategy. *Journal of Alternative and Complementary Medicine* 12(3): 255-263.

Shen, M.Q., Ye, Q.Z., Ding, Y.F. and Luo, Y.H. (2010). Study on *Cornu bos grunniens* from Tibet substituting Cornu *rhinoceri*. *Journal of Chinese Medicinal Materials* 31(6): 813-815.

Shigematsu, N., Kouno, I, Kawano, N. *et al.* (1982). On the water-soluble amino acids in Saiga tatarica and Rhinoceros spp. *The Japanese Journal of Pharmacognosy* 36(1): 104-105.

Smith, M. (2012). *The Saigon Horn: Part 2*. 15 February 2012. Viewed on 16 February 2012, http://www.groundreport.com/Business/The-Saigon-Horn-Part-2/2944288

Song, B.X., Cao, L., Jie, E.Y *et al.* (2010). Research of Antipyretic, Analgesic and Anti-inflammatory effect of Rhino Horn. *Traditional Chinese Medicine and Clinical Pharmacology*.

Song, C. and Milliken, T. (1990). The rhino horn trade in South Korea. *Pachyderm* 13: 5-11.

Tang, J.L., Zhan, S.Y. and Ernst, E. (1999). Many randomized trials of Traditional Chinese Medicine exist but are of poor quality. *British Medical Journal* 319(7203): 160-161.

Tombolato, L., Novitskaya, E.E., Chen, P.Y., Sheppard, F.A. and McKittrick, J. (2010). Microstructure, elastic properties and deformation mechanisms of horn keratin. *Acta Biomaterialia* 6 (2010): 319-330.

TRAFFIC. (1998). *Research on import and domestic trade in wildlife used as Kampo medicines.* Report for Japan Economic Foundation, TRAFFIC, Tokyo, Japan.

Tsai, F.J. (1995). Antipyretic Effect of Xi Jiao [Rhino horn] and Shuiniujiao [Water buffalo horn] in Children. *Annual Report of Chinese Medicine and Pharmacy* 329-337. Taipei, Taiwan.

Tu, Y.Y. (2011). The discovery of artemisinin (qinghaosu) and gifts from Chinese medicine. *Nature Medicine* 17(10): 1217-1220.

Vickers, A., Goyal, N., Harland, R. and Rees, R. (1998). Do certain countries produce only positive results? A systematic review of controlled trials. *Controlled Clinical Trials* 19: 159-166.

Wang, F., Duan, J.N., Qian, D.W. *et al.* (2007). Searching for Substitutes for Cornu Rhinoceri Asiatici and Cornu Saigae Tataricae and Evaluation(II). *Journal of Nanjing TCM University*.

Wen, H. and Park, K. (2010). *Oral controlled release formulation design and drug delivery: theory and practice.* Wiley and Sons.

Wu, B., Liu, M., Liu, H., Li, W., Tan, S. *et al*. (2007). Meta-analysis of traditional Chinese patent medicine for ischemic stroke. *Stroke* 38: 1973-1979.

Wu, B.P. and Lu, S.K. (1986). Discussion on the possible treatment of AIDS with traditional Chinese medicine. *Beijing Journal of Traditional Chinese Medicine* 1: 14-16. In But *et al.* (1990).

Wu, J. (2007). World Without Borders: Wildlife Trade on the Chinese-language Internet. TRAFFIC Bulletin, v.21(2):75-84.

Yamamura, S., Morita, Y., Hasan, Q., Yokoyama, K. and Tamiya, E. (2002). Keratin degradation: a cooperative action of two enzymes from *Stenotrophomonas sp. Biophysical and Biochemical Research Communications* 294(5): 1138-1143.

Yan, D., Han, Y.M., Luo, J.Y. *et al.* (2010). The action of medicinal animal horns on *Escheria coli* growth investigated by microcalorimetry and chemometric analysis. *Chinese Science Bulletin* 55(26): 2945-2950.

Yang, S. (2011). *A review of rhino horn*. Report on structural biomaterials for Franklin W. Olin College of Engineering.

Ye, J. and Yuan, W.J. (1989). A case of ox horn used as a fake rhino horn. *Fujian Medical Journal* 1989: 33-36.

Yuan, W. (1987). Rhinoceros horn. In HM Chang and PPH But (eds.) *Pharmacology and applications of Chinese material medica*, Volume 2. World Scientific Publishing Co., Singapore, 1178-1179.

Zhou, J.M., Yu, J. and Hong, H. (2010). Quick identification of rhinoceros horn and its products. *Journal of Northeast Forestry University* 38 (5): 140-141.